

Second Examination in Engineering. COMMON TO ALL BRANCHES.

MATHEMATICS.

Pure Mathematics.

Differential and Integral Calculus.—Successive Differentiation. Tangents and Normals. Subtangent, Subnormal Points of Inflection. Partial Differentiation. Mean value Theorem. Indeterminate forms. Expansion of Functions. Asymptotes. Singular points. Curvature. Envelopes. Evolutes. Tracing of Curves, Plotting of Functions. Determination of Laws.

Methods of Integration. Reduction Formulae. Integration as the limit of a sum. Length and Areas of Plane Curves. The Planimeter. Volume and Surface of Solids of Revolution, Successive Integration: Double and Triple Integrals. Application to Centre of Mass, Centre of Pressure, Moments of Inertia, etc.

Differential Equations: Equations of the first order; Homogeneous Equations; Linear Equations with Constant Coefficients; Homogeneous Linear Equations; Simple Linear Equations of the Second Order.

Applied Mathematics.

Dynamics.—Composition and Resolution of Velocities and Accelerations. Falling Bodies. Relative Velocities. Angular Velocity and Acceleration.

Laws of Motion. Work, Power and Energy. Motion in a Circle. Simple Harmonic Motion. The Simple Pendulum. Impact of Elastic Bodies.

Motion of a particle in two dimensions under given forces: Projectiles, Constrained Motion.

Moments of Inertia. D'Alembert's Principle. Rotation about a fixed axis. Motion of a rigid body in two dimensions. Instantaneous centre of rotation.

Statics.—Concurrent Forces. Friction. Parallel Forces. Moments. Couples. Equilibrium of Forces in a Plane. Centre of Mass. Simple Machines (The Pulleys. The Wheel and Axle. The Differential Pulley. The Screw. The Balance. The Steelyard).

Principle of Virtual Work. Stable and Unstable Equilibrium. Equilibrium of Strings and Chains. The Parabolic Chain. The Catenary. Forces in three Dimensions: Composition and Resolution and simple Problems.

Hydrostatics.—General Theorems relating to Pressure. Thrust on a Plane Area. Centre of Pressure. Resultant Thrust on any Surface. Equilibrium of Floating Bodies. Stability; Metacentre. The Principles underlying the action of the Suction Pump, the Force Pump, the Centrifugal Pump, the Syphon, the Hydraulic Press.

APPLIED MECHANICS AND GRAPHIC STATICS.

I. *Mechanics of Materials.*

Simple Stresses and Strains.—Modulus of Elasticity, permanent set, elastic limit, yield point, ultimate strength, resilience, and fatigue of metals; effect of hardening, tempering and annealing. Measurement of hardness. Modulus of rigidity, bulk modulus; effects of temperature changes.

Dead and Live Loads.—Working stresses and factors of safety, Laundhardt and Weyrauch's formulae, the dynamic and other formulae and results of experiments. Effect of impact and stresses due to suddenly applied loads. Resilience.

Compound Stresses and Strains.—Ellipse of stress and its application to investigate the stability of earth-work. Principal Planes and principal stresses.

II. *Strength of Materials.*

Testing Machines and Testing of Materials.—Forms and arrangement of testing machines for compression, tension and torsion and bending tests. Instruments for measuring extension, compression and twist. Influence of form on elongation and strength. Methods of ordinary commercial testing. Laboratory records giving stress-strain diagrams of testing with the results of tests conducted. Test conditions in specifications for cast iron, steel and cement. Mechanical properties of the materials used in Engineering construction.

III. *Theory of Structures.*

Theory of Simple Bending.—Transverse stress, beams, girders, cantilevers. Graphic and Analytical methods for calculating bending moments and shearing forces and of stresses in individual members of the framework of structures loaded at the joints both for steady and moving loads. Graphical methods of drawing the bending moments and shear force diagrams for a travelling load system by Claxton Fidler; other graphical methods. Influence lines and their application to bending.

Moment of Resistance.—Strength and stiffness of beams, modulus of rupture. Beams of uniform resistance.

Shear distribution in a beam cross section and graphical methods. Stress distribution in combinations of materials. Stresses in ferro-concrete beams.

Deflection.—Relationship between curves of loading, shear force, bending moment, slope or curvature and deflection. Analytical and graphic methods of determining the deflection of various cases of loading and supports. Mohr's theorem.

Fixed and Continuous Beams.—Analytical and graphical methods of determining bending moments and shearing forces. Encastre beams and continuous beams, Theorem of the three moments.

Design of Struts and Columns.—Use of standard formulae such as Euler's, Rankine's, Gordon's, Fidler's, Johnson's and Straight line formulae in the design of struts. Curves showing comparatively the strength of struts obtained by various formulae; choice of sections; joints, design of end bearings and methods of supporting or fastening the ends of struts and stanchions.

Moments of Inertia.—By analytical and graphical methods and Radii of gyration.

Design of Pin Connected and Riveted Joint.—Methods of failure, efficiency and practical considerations in design.

Theory of Torsion.—Strength of shafting and other practical applications.

Springs.—Spiral, Volute and Carriage springs.

Stresses in shells and thick cylinders.

Miscellaneous Structures.—Theory of the hanging chain; elastic theory of arches masonry arches, rigid and hinged arches. Stability of masonry and brick work structures such as dams, weirs, retaining walls; Strain due to weight of structures and wind pressure; Chimneys and towers. Graphical treatment of simple cases. Theory of earth pressure and of foundations. Rankine's Theory, Wedge Theory.

Principles of Graphic Statics.—Graphical methods of dealing with forces and reactions and general principles of the force and equilibrium polygons for determining stresses in simple trussed or fabricated structure.

Rotor and Vector quantities. The Triangle and Parallelogram of forces. The Vector polygon, funicular polygon; Bow's notation. Conditions of equilibrium of concurrent and non-concurrent forces. Definition of a structure, simple and compound structures. Perfect, imperfect and redundant frames with examples.

In addition to the courses prescribed under Applied Mechanics for moments, centroids and momental ellipse, graphical solutions of bending moments and shear diagrams, the following should be dealt with:—Deflection by graphical methods; graphical treatment of masonry and metal arches; Masonry dams, anicuts, foundations, abutments, piers, retaining walls and other masonry structures such as chimneys and towers; Solution of stresses in framed structures by (i) Clerk-Maxwell's reciprocal figure method, (ii) Ritter's method of sections or moments, (iii) Resolution.

Frames of different kinds of roofs under different conditions of loading including wind pressure. Stresses in individual member of simple roof trusses and frames and girders: the Derric, Tripod, King Post, Queen Post, French roof truss, Station roof truss, Crescent roof, Three pinned arch, North light roof truss, Bollman, Fink roof truss. Effect of fixing of ends.

Warren, N. Girder, Pratt, Hogback, N. Girder, Whipple Murphy Truss. Bow string girder; Dead load stresses on Bridge trusses and girders. Retaining walls; Masonry dams, anicuts, tall chimneys, towers of masonry and steel; Graphical treatment for earth pressure.

HYDRAULICS.

A thorough course in Theoretical Hydraulics in the 2nd and 3rd Years is followed by a course in the Fourth Year in Hydraulic Engineering in which both the estimation and utilisation of Hydraulic Power are discussed.

Hydrokinetics.—The flow of a fluid. Modes of motion of water. Total energy of flowing water; Bernoulli's Theorem: Venturimeter. Horse power of a jet. Radiating Current, Vortex Motion. Flow of gases. The Pitot tube.

Discharge from Orifices and Mouth-pieces.—Flow through small orifices, Coefficients. Measurement of Water by orifices. Application of Bernoulli's Theorem to flow from orifices. External and internal mouthpieces. Large vertical orifices and drowned orifices. Losses of head of flowing water. Sudden enlargements, contractions and obstructions. Time of emptying vessels through orifices.

Notches and Weirs.—Rectangular, Triangular and Trapezoidal notches. Velocity of approach. Partially and fully submerged orifices. Drowned and broad crested weirs. Researches of Francis, Bazin, Rafter and others. Principle of similarity. Separating Weirs. Time of emptying reservoirs by weirs. Flood absorptive capacity of tanks. Practical cases of discharge from orifices and notches, anicuts, tank weirs; irrigation. Tank and Canal sluices; Bridge openings. Afflux and Backwater. Canal locks. Discharge from irregular basins.

Fluid Friction.—General Laws. Froude's experiments.—Friction of discs rotated in water. Resistance of ship and influence of temperature. Flow through pipes. Hydraulic.

gradient and hydraulic mean radius. Loss of head due to friction in pipes. Impacts at bends and thrust blocks. Chezy formula and Darcy's coefficients. Reynold's experiments and critical velocity. Flow through long and short pipes. Inlet resistance. Secondary losses in pipe flow. Siphon.

Detailed Investigation of flow through Pipes.—Kutter's Formula. Defects of Chezy's formula. Discussion of a general formula for flow through pipes from available experimental data. Researches possible and the value of the constants and the exponents involved in the formulæ.

Fluid Distribution in Pipes.—Town water supplies, mains, break, pressure, reservoirs. Hydraulic gradient of pipes of variable diameter. Pipes connecting two reservoirs and delivering water en route. Parallel flow through pipes. Pipes not running full. Dupitt's equation. Pumping main section pipe of pumps, water hammer, flow of gases through pipes. Transmission of power through pipes. Nozzles. Study of Water meters.

Irrigation Hydraulics.—Flow in channels and conduits; uniform and steady flow of constant slope and sections. Velocity of flow, surface fall. The researches and formulæ of Chezy, Darcy, Gauguliet, Kutter and Bazin and their application. Formulæ to be adopted for channels in practical design. Rectangular, trapezoidal and circular channels. Economic sections. Channels for variable discharge. Egg-shaped and ovoid conduits.

Parabola of discharge, depression of the point of greatest velocity. Vertical and transverse velocity curves. Ratios of mean surfaces, maximum and bottom velocities. Minor losses of head at entry and bends. Canal falls, water cushion, standing waves.

Discharge in Rivers.—Irregular channels: variable and non-steady flow. Characteristics of river flow. Estimation of river flow. Estimation of river discharges, various methods, comparative merits. Direct method by measuring velocity. Principles involved, Description of methods, surface and other floats and velocity rods. Current meters and measurement of discharge. Harlachar, Price and other meters. Rating of meters. Calculation of discharge from vertical velocity. Curves and contours of equal velocities. Pitot tube and Darcy gauge. Hydrodynamometer: Gauging streams by chemical means and by ripple formations. Rainfall and run off calculations for maximum discharge from catchment; river bends and regime of rivers.

APPLIED MECHANICS—TESTING LABORATORY.

Scientific Tests for study of the behaviour of Engineering Materials under Stress.

Testing Materials for Tension, Compression, Torsion, Impact and Fatigue.—The materials testing laboratory equipped with a testing machine for tension and compression tests; Transverse tests of beams and trusses up to 16 feet in length; use of extensometers for accurately measuring the elongation of test specimens and determining the modulus of elasticity.

Torsion machine for conducting torsion tests of shafting up to 2' and 1½" diameter and 16 feet length.

Laboratory tests of cements with cement testing machine for testing their strength.

Commercial Tests.—Commercial tests of iron, steel, brass, copper, cement, stone, brick and timber. Tests to be carried out according to the B.S. specifications and results compared with the requirements of those standards.

Determination of strength and elastic constants and the variation of these with the rate of loading. Temperature and mode of application of the load.

Tests for fatigue of materials; simple bend tests; hardness tests; impact tests; testing of long and short columns; shearing tests; torsion tests.

Use of extensometers and autographic recorders. Tension and torsion of wire and wire-ropes and chains. Lubricating oils, pressure gauges and heat value of fuels.

Engineering Laboratory.—Use of indicator, determination of horse power with elementary experiments necessary for a complete knowledge of the methods of testing. Use of friction brakes. Testing of different types of calorimeters. Power and economy standard tests of simple engines and the more common steam and hydraulic machinery.

Hydraulic Laboratory.—Tests on discharge through different orifices; calibration of rectangular and triangular notches. Coefficients of velocity, discharge and contraction. Friction in pipes. Tests on hydraulic ram, pulsometer, reciprocating and centrifugal pumps; and on pelton wheel, and reaction and impulse turbines.

CIVIL BRANCH.

MECHANICAL ENGINEERING.

Lubricants.—Classes of lubricants.—minerals, vegetable and animal sources. Qualities and properties of lubricants. Types of lubricants.

Bearing.—Design of simple bearings.

Transmission of Power.—Velocity ratio in friction and simple toothed gears, belts and ropes, shafts and couplings.

Fuel.—Types of fuel—solid, liquid and gaseous. Their advantages and disadvantages. Carbonisation of coal and manufacture of coke, manufacture of charcoal and refinement of oil.

Boilers.—Various types of boilers—vertical, land and marine, such as Lancashire, Cornish, Water tube, Smoke tube, Locomotives and Yarrow boilers. Types of furnaces and methods of firing boilers by hand.

Steam Engines.—Properties of steam. Entrophy diagram. Calender's equation. Carnot's perfect engine. Rankine's cycle. Engines—simple, compound and multiple expansion engines. Pumps and air compressors. Steam turbines. Operation and care of road roller and portable engines.

Various types of Condensers.—Atmospheric, jet, surface condensers.

Internal Combustion Engines.—Gas, oil, and petrol engines. Two strokes and four strokes, principles of operation. Maintenance and running.

Simple description of the use and working of hoists, cranes, winches, crabs, excavators, etc., and other machinery met with in Civil Engineering Practice.

Indicators.—Types of indicators, indicated and brake horse power, types of brakes.

Industrial Hydraulics.—General description of and methods of working of the Hydraulic Appliances in Engineering, special attention being given to the working of the various Pumps and Pumping Machinery.

Pumps.—Classifications—Reciprocating, Rotary, Semi-Rotary, Centrifugal and Turbine Pumps. Lift, Force, Bucket, Piston and Plunger Pumps. Single-acting, Double-acting, Direct-acting, Simplex and Duplex Pumps. Gear-driven, Two-throw or Three-throw horizontal or vertical Pumps, and deep well Pumps. Simple Steam Pumps like the Vertical Donkey, Worthington Duplex, Worthington High Duty Pump.

Pistonless Pumps.—Hydraulic Ram; Pulsometer; Humphrey's Internal Combustion Pump. Compressed Air Lift Pumps.

Centrifugal Pumps.—Single-stage, Multi-stage; Low-lift, Medium-lift and High-lift. Characteristics of performances. Care in erection, connections and operation. Centrifugal pumps for sewage and other heavy pumpings.

Simple Theory about Slip losses, Hydraulic losses, Mechanical losses, Work done and diagram of work for pumps, suction and delivery. Air vessels on the suction and delivery sides, Pump Efficiency, Engine or Motor Efficiency. Horse power and Pump characteristics.

Simple method of erection and operation of pumps. Calculations for installing of Pumping stations and Pipe lines.

Water Wheels and Turbines.—Elements of Hydraulic Power generation and transmission; and advantages and disadvantages. Working of the overshot, undershot and breast wheels and the pelton; Impulse and Reaction Turbines; Inward flow, outward flow and Axial flow; Governing Principles.

Hydraulic Machines.—Accumulator, Differential Accumulator, Intensifier, Hydraulic Press, Hydraulic Cranes, Hydraulic Jack, Hydraulic Riveter, Hydraulic Joints and Packings.

Elementary description of the Principles of Hydro-Electric-Development.

ELEMENTARY ELECTRICAL ENGINEERING.

Electrostatics. Magnetism. Electromagnetism. Properties of Materials, Conductors and Insulators. Ohm's law and Kirchhoff's circuit laws and applications. Measurements and Measuring Instruments. Principle, description and use of Ammeter, Voltmeter, Ohmmeter, Current Balance, Wheatstone's Bridge and Potentiometer. General Principles of Alternating Currents. Generation of E.M.F. Waveform, form-factors. Vector representation of complex quantities. Capacity, Inductance and resistance in Circuits. Symbolic method of solving A.C. Circuits. Simple A.C. Measurements and Measuring Instruments.

Electric Power, Units, relation to Mechanical Unit, Heating Appliances and Problems.

Electrical and Mechanical Properties of Wire; Pure metals, alloys. Insulated Wire, size wire for interior wiring.

Magnetism and Magnetic Circuits.—Electromagnetic Induction. D.C. Dynamos and Motors. Regulation and Control. A.C. Generators and Synchronous Motor. Production of Rotating Field by poly-phase currents. Induction Motors. General characteristics and applications.

Storage Battery and Lightning Conductors, Installation and Testing.

WORKSHOP.

Smithy.—Drawing out tapers. Bending at right angles. Bending into a chain link. Making bolts and nuts, keys and cotters. Tap and ring welding.

Foundry.—Levelling. Preparing moulds with or without patterns for simple objects. Moulding straight pipes, elbows, tees, etc. Core making. Simple exercise on the Machine moulding.

Machine Shop.—Plane turning, taper turning, groove cutting, square thread and V-thread. Dyeing and tapping. Cast iron and brass work.

MACHINE DRAWING.

Riveted Joints.—As used in the construction of steel trusses, steel tanks, bridge work, etc.

Pipe Joints.—Flange joints, expansion joints, spigot and socket joints, Macnaughtan's joints, Armstrong's hydraulic pipe joints, etc.

Cottered Joints.—For tension and compression rods.

Foundation Bolts.—Rag bolts, Lewis bolts, cottered bolts, etc.

Bearings, Stuffing Boxes, Valves, etc.—As used in pumping machinery.

BUILDING CONSTRUCTION.

Foundations.—Natural and artificial foundations, piles and pile driving, friction, bearing and pedestal and compressol piles, wells and tubular foundations, reinforced concrete rafts and sub-structure.

Plinth, Basement, Floor.—Damp proof courses—vertical, horizontal. Dry area to basement, cavity and hollow walls.

Brick Work.—Walls, piers and pilasters, old and new brick work, grouting, diagonal and herring bone bond, perpends, fire place and flues, staging and scaffolding, moulded plain and gauged brickworks, fixings and openings.

Stone Masonry.—Conversion of stones, tools and dressing face work and backing, coping, throating and cornices, quoins, squint quoin, pointing, face work. Varieties of mortar and jointing—keyed, joggle and lock joints, dowels, plugs, keys and cramps.

Plastering.—Materials, plaster grounds, plastering mixtures, stucco and plain and rough cast. Hard, smooth, shell lime and gypsum, wood and metal laths, cornices and mouldings. Fibrous plaster and ornamental plaster.

Arch work.—Centering and timbering, segmental, elliptic, 3 and 5 centred, pointed, ogee and horse-shoe, skew, hogback and stilted arches. Domes and vaults, buttresses and abutments. Striking centres.

Carpentry.—Timber joints, wedges, keys, pins, tree-nails, spikes, etc. Flooring and ceiling and roof frames. Queen post and Mansard roof trusses, screw coupling, jib and cotter joints.

Joinery.—Doors, windows, partitions, panelling, moulding veneering, panelled doors, framing and hanging of doors, double doors, swing doors, door jamb linings, fanlights, architraves, skirtings and picture rails, sash and casement windows, venetians and louvers, skylights and lanterns.

Construction in Metal.—Wrought and cast iron ornamental work, grillage and gates. iron; cast iron columns, pressed metal ceilings and cornices. Steel castings and bronze work. Structural shapes, built up stanchions and struts, cast iron columns with ribbed base.

Roof Frames.—Girder and arch frames, French and English systems of bracing, secondary bracing curved and crescent roof frames, ridge and furrow system, saw tooth roof, joints at ridge and shoe and skylights.

Flooring.—Wood block, boards, parquet.

Stair Cases.—Wooden, stone, metal and reinforced, cut and close strings, hand rails and balusters and newels.

Fireproof Construction.—Reinforced concrete, hollow block and bulk timber construction.

Roof Coverings.—Varieties of tiles, slate and terraced and reinforced concrete roofs, valleys and hips and ridges and eaves, shingles.

External Plumbing.—Lead work or zinc sheets in valleys, flats and flashings, gutters and dormer windows, drip moulding.

Glazing.—Varieties of glass window and door glazing, roof glazing, pavement lights and decorative glass, lanterns and domes, putty glazing, leads and glazing bars.

Hardware.—Varieties of hinges, bolts and locks and finger and name plates.

Painting and Decoration.—Oil paints and varnishes, calcarium and distemper wash, enamels, wall paper, stencils.

Architecture and Town Planning.—Architectural design—Design of residential bungalows, stationary structures for factories and power installations with special reference to selection of site, construction of walls and roof, lighting and ventilation and water supply and drainage.

Tall masonry and steel and reinforced chimneys, theory and design.

Design of steel and masonry service reservoirs for water and oil.

Reinforced Concrete.—Nature, use, properties, advantages and disadvantages over other methods of construction. Assumptions made in theory of stresses in R. C. beams. Design of single and double reinforced beams. Continuous beams for different conditions of loading. R. C. columns and retaining walls.

PRINCIPLES OF ARCHITECTURE.

The course aims at developing the habit and faculty of noticing visible beauty in contemporary art, in public monuments, in designing and also in personal environment of an Engineer such as furnishing and decorating the home and machinery and other structures.

Fundamental Principles of Architectural Design.

Architecture as a fine art. Necessity to deliberate on fundamentals, requirements of beauty and utility. The building beautiful—æsthetic appreciation based on intellectual judgment and satisfaction derived from fitness, expressiveness and appropriateness.

Principle of Design—pictorial, sculpturesque, decorative and structural and their value in criticism, analysis and teaching only.

I. *Pictorial Principles.*—(1) Pictorial setting. A building to be consistent with natural surroundings to conform to the character of the landscape and of the neighbourhood.

A structure as a picture with enveloping foliage, etc., colour and texture of walls, roofs, etc., to suit the radiant sky or gloomy atmosphere.

(2) Balancing solids and voids; Harmonious disposition of solid wall piers and door, window, or arch openings.

Appearance of stability dependent on predominance of solids over voids.

(3) Refinement in visuality of motives purity of form and profile. Beautifying the common place, aim of architect. Beauty in simple ratios and recognisable proportions; straight and angular forms are crude and primitive.

(4) Vitality of shape and form; alteration and contrast; variety and picturesqueness.

II. *Sculpturesque Principles.*—(i) Contrast of light and shade. Architectural form defined and determined by variation of light and shade, projections and recesses.

(2) Breadth and restraint in treatment; quietness and simplicity. Elimination of the unnecessary essential for dignity.

(3) Expression of purpose. Virtue of art is sincerity of purpose; external features, the logic outcome of internal need.

III. *Decorative or Abstract Principles.*—(1) Unity of conception. Precedence and subordination of features. Focus or central feature necessary for effect. Architectural dignity, the result of similarity and consistency in motives and details.

(2) Proportion and Scale. Proper relation of the several parts to one another and to the whole. Magnificence and importance of buildings measured by apparent size and large scale.

IV. *Structural Principles.*—(1) Suitability of Material. Building Materials shaped with art and handled with science: Architectural forms suited to structural material.

(2) Expression of Construction. Union of the practical with the æsthetic, the essence of structural art. Artistic expression, result of constructional appropriateness. Decoration to be consistent with structural function.

(3) Stability, truth and fitness. Apparent and real stability, necessary for beauty. Monumental structures always pyramidal in shape.

(4) Principles of tradition. Fine arts founded on principles unsusceptible of change. Knowledge of preceding works necessary for invention in Architecture. Accurate vocabulary of form required for successful design. Traditional background essential to creative art requiring no intellectual effort.

History of Architectural Development.

Architecture: a record of man's effort to beautify his surroundings; materials and structural shapes.

Historic style corresponds to contemporary civilisation. Prehistoric dwellings. Caves and log cabins.

Growth of Historic styles in the East.—1. Buddhist stupas, Chaityas and caves, Dravidian Kath; Temples, Cars and Palaces.

2. Chalukyan—Mantapams, Quadrangles and Pavilions.

3. Jaina—Hill Temples, Pillars, Towers of Victory, Porches.

5. Indo-Aryan—Rock cut temples, Golden Temple, Palaces, River Ghats.

5. Pathan Style—Tombs and Mosques.

6. Indo-Saracenic and Moghul—Gateways, Masjids, Mosques and Tombs Palaces.

7. Chinese and Japanese—Temples, Pagodas and Tombs. Porcelain Tower and Pavilions.

8. Modern Indian Architecture—Bikanir, Jaipur, Jodhpur.

Development of Historic Styles in the West.—1. Egyptian Tombs, Temples. Pylons and Obelisks.

2. Assyrian, Persian and Sassanian—Halls and Palaces.

3. Greek—Temples, Tombs, Gateways, Towers and Amphitheatres.

4. Roman—Forum or Market place. Temples, Basilicas (Law Courts, Stock Exchange) Public Baths, Theatres, Amphitheatres, Triumphal Arches, Columns of Victory, Aqueducts and Bridges.

5. Early Christian—Baptistries. Churches and Tombs.

6. Byzantine—Churches and Halls.

7. Romanesque—Vaulted Halls, Bell Towers or Campanile, Cloisters.

8. Gothic (Mediaeval and Flamboyant)—Cathedrals. Parish Churches, Castles and Chateaus. Military Fortresses, and Civic and College Buildings, Palaces, City Gates.

9. Renaissance (Classic and Rococo)—Italian, German, French and English Palaces, Churches and Libraries.

10. Modern and Classic Ideal—Civic, Secular, Religious and Business premises, Theatres, Operas, Museums and University Buildings.

BUILDING DRAWING AND ESTIMATING.

Making out Drawings accurately to scale with additional views and sections from measurements of actual buildings and from given sketches, and tracing them; Making proportionate intelligible dimensioned sketches of existing works without taking actual measurements of works in progress, and producing scale drawings therefrom; Designing and Drawing; Drawing small buildings in full to conform to given accommodation or at specified cost; Making out large scale drawings of building parts involving elementary principles of Architectural Art.

Estimating.—Taking out quantities with costs from drawings of Buildings, simple Culverts and Small Irrigation works such as Weirs and Sluices; Calculating and Writing out of cost; Standard specification and data of materials and Labor for the items of works required for the structures detailed above.

The students will be required to make up drawings and produce estimates with calculations necessary in the preparation of projects and for contracts—together with all detailed drawings requisite for the actual execution of a building with the usual scale for such drawings and all information to be contained in them.

WATER, SUPPLY AND SANITARY ENGINEERING.

(a) Water Supply.

Value and Importance of Water Supply.—Development of Modern Water Works in Europe and America. Domestic, Commercial and Public requirements.

Quantity of Water required.—Sources of supply. Rainfall. Evaporation and Percolation. Estimation of flow of streams and Ground waters.

Quality of Water.—Pollution. Water borne diseases. Sanitary Survey and Conservation of catchment and basin. Water analysis.

Construction of Water Works.—General principles of economic construction and arrangement of the several works.

Works for the Collection of Water with reference to the several sources.—Purification of water. Chemical precipitation, slow and rapid filtration; modern method of sterilisation and aeration. Construction and maintenance of works for the above.

Pumping and Distribution.—Systems of supply schemes. Pipes and conduits—Pumping machinery. Service Reservoirs, Water Towers and Standpipes, Distribution systems and details of distribution line, such as Valves, Hydrants, Meters and other appliances. Maintenance and repairs.

(b) Sanitary Engineering, Drainage and Sewerage.

Objects of a scheme. Contrast between European and Indian conditions. Surface Drainage Schemes for removing stagnating rain water. Underground sewerage systems and the general arrangement of the several works. Principles of design. Data to be collected. Allowance for inclusion of the foul part of the rainfall. Size, velocity and gradients of sewers. Selection of a suitable system and evolution of a scheme. Design of the several necessary works on a sewer line.

House drainage.—Water closets, taps, soil and other pipes, sinks, lavatories, urinals and baths.

The Sewer Line.—Laying and joining and testing of sewers. Construction of manholes, flushing tanks, overflows junctions, catch basins, inverted syphons, etc. Public conveniences. Maintenance of a sewer line.

Pumping Sewage.—Pumping stations, automatic and other types of ejectors.

Disposal of Sewage.—Treatment of sewage before disposal. Objects. Characteristics of Sewage. Physical and Biological aspects of Sewage treatment. Modern Methods of treatment including the diffused air and other processes.

(c) Municipal Engineering.

Its scope and aim. Duties of a Municipal Engineer. Size and growth of cities. Population. The city. Its Plan, as determined by the streets. Design, construction and maintenance of streets, side walks, curbs, etc. Street lighting, signs and numbers. Collection and disposal of the city wastes. Markets, Parks, Cemeteries and shade trees.

(d) Town Planning.

General principles. Suitability of an area. Boundaries. Adaptation of design to natural features. Allocation of areas for the several classes of buildings, parks, open spaces—plying grounds. Advantages and disadvantages of private open spaces. Improvement of existing condition of cities by removing congestion. Developing garden suburbs or extensions. Ornamenting and beautifying of towns.

SURVEYING (THEORY AND PRACTICE).

Theory.

Plane Tabling.—Advanced Methods. Tangent Clinometers. Theory and use of the stadia method of Plane Tabling in topographic surveys.

Levelling.—Theory, simple, compound, check and reciprocal levelling. Hand levels and Clinometers. Varieties of levels and their adjuncts. Comparative merits of the methods of construction methods of using them. Fly levels, longitudinal and cross sections. Errors in levelling. Methods of avoiding and minimising them. Permissible error. Problems in levelling.

The permanent adjustments of a level. Theory and Practice.

The Sextant and Theodolite.—Construction of the Hadley's and Box Sextants and the Theodolite. Setting up of a theodolite and measurement of horizontal and vertical angles. Running and prolonging of straight lines. Simple cases of trigonometric levelling. Uses of the Theodolite and Sextant in Surveys. Conducting traverses by Gale's and other methods and plotting the results. Setting out of centre lines for installing machinery, buildings, etc., working out simple curves.

Advanced Levelling.—Barometric, Hypsometric and Trigonometric Levelling Sections and contours. Use of contour plans in Engineering projects. Use of the Level Clinometers, the Theodolite and Plane Table in making contour plans. Working up a typical project. Setting out of grades and use of Boning rods.

The Use and Adjustment of the Theodolite.—Types of Theodolites and their use. The principal axes of the Theodolite, and their adjustments.

Traversing with the Theodolite. Gale's Method for city and other surveys. Traverse table and calculations. Errors in theodolite work, Remedies adopted.

Setting out of Masonry and Earthwork and simple curves.

Practice.

Practical work of handling the above surveying instruments and conducting surveys in the field. Solution of Engineering problems. Each student is expected to prepare and submit field notes, records and drawings as evidences of field work done by him.

MECHANICAL BRANCH.

BUILDING CONSTRUCTION.

Foundations.—Good and bad foundations of sites, safe bearing power of soils ordinarily met with. Masonry footings and ordinary mass concrete foundations. Fixing and foundations for heavy machinery and electric motors. Holding down bolts and anchor plates. Isolating heavy machinery. Vibration, its cause and effects.

Brick Work Masonry.—Ancient and modern brick masonry. Terms and bonds in brickwork. Bond, Closers, bedding, racking back, plastering, pointing, coping, cornice, blocking, course, parapet wall, corbel, reveal, sill, hollow walls, reinforced brick work. Erection of brick chimneys. Scaffolding, Derrick, Gantry, retaining walls.

Stone Masonry.—Uncoursed and coursed rubble, ashlar size stone work. Blocks in course, bond, safe load, Lewis, Dowel, Joggle, Cramp, Template, shears. Dressing such as window sills, window and door jambs and reveals. Revetments. Construction, and sinking, of masonry wells.

Wood Work.—Teak wood wrought and put up, joints such as halving, lapping, notching as applied to wall plates, floors, ceilings, partitions, screens and posts.

Roof Frames.—Couple rafters and simple king and queen post trusses. Simple iron frames, purlins hips and gables.

Doors.—Ledged and braced, framed. Ledged and braced windows, pannelled, glazed and venetianed.

Staircase.—Plain, dog-legged and newel staircases.

Roofs.—Sloping and flat, thatch, country; pan and Mangalore pattern tiles, Madras and jack arched terraces and saw tooth roof.

Arches.—Definitions of terms used in archwork, gauged, relieving, and inverted arches.

Rolled Steel Sections.—Sizes of rolled steel joists, and girders, and simple appliances.

Flooring.—Plaster, tiles, Cudapah and burnt stone slabs cement and granolithic floors.

Reinforced Concrete Construction.—Practical use of reinforced construction work in beams, floors and columns. Water and Oil Tanks. Fireproof construction.

Tall Masonry and Steel Chimneys.—Theory and design.

PRINCIPLES OF ARCHITECTURE.

Same as for Civil Branch.

ELECTRICAL ENGINEERING.

Electrostatics—Magnetism—Electromagnetism—Self and Mutual Induction—Properties and materials of Conductors and Insulators—Electric Circuit Laws, Alternating Current Theory—Storage Battery. Electrical Measurements and Measuring Instruments—Elementary Theory of D.C. Dynamos and Motors.

SURVEYING (Theory and Practice).

Theory.

Plane Tabling.—Advanced Methods. Tangent Clinometers. Theory and use of the stadia method of Plane Tabling in topographic surveys.

Levelling.—Theory, simple, compound, check, and reciprocal levelling. Hand Levels and Clinometers. Varieties of levels and their adjuncts. Comparative merits of the methods of construction methods of using them. Fly levels, longitudinal and cross sections. Errors in levelling Methods of avoiding and minimising them. Permissible error. Problems in levelling.

The permanent adjustment of a level. Theory and Practice.

The Sextant and Theodolite—Construction of the Hadley's and Box Sextants and the Theodolite. Setting up a theodolite and measurement of horizontal and vertical angles. Running and prolonging of straight lines. Simple cases of trigonometric levelling. Uses of the Theodolite and Sextant in Surveys. Conducting traverses by Gale's and other methods and plotting the results. Setting out of centre lines for installing machinery, buildings, etc. Working out simple curves.

Practice.

Practical work of handling the above surveying instruments and conducting survey in the field. Solution of Engineering problems. Each student is expected to prepare and submit filed notes, records and drawings as evidences of field work done by him.

THEORY AND DESIGN OF MACHINES.

Mechanics of Engineering—Strength, properties and testing of materials used in machines, cast iron, wrought iron, mild steel, alloysteels and anti-friction metals.

Kinematics.—Definition of a machine. Machine elements and pairs. Laws of motion. Constrained motion. Parallel motion. Combinations of pure mechanism. Mechanisms obtained by inversion.

Links and Chains.—Conic Crank chain. Virtual centres, centrodes, Relative linear and angular velocity. Displacement, velocity and acceleration diagrams. The reciprocating motion of the slided crank chain. Klein's, Bennet's and Ritterhaw's construction. Straight line motors.

Higher Pairing.—Friction gears, toothed gears and screw gears. The forms of wheel teeth—Involute and cycloidal. Belt and rope gearing—their purpose and principles underlying their design.

Dynamics of Machines.—Forces involved in the moving parts of machinery. Graphical and analytical methods of determining accelerating forces. Friction, friction circle and friction axis of a link and dead angle. Conditions of static equilibrium of machine. Crank effort, crank effort diagrams. Fly-wheels and governors. Balancing of machines.

Dynamics of Engines.—Fundamentals of inertia, balancing in forms of reciprocating engines in general use.

Packing and Jointing Materials.—Carbon packing. Packing for Hydraulic cylinders. Alloys for metallic packing. Jointing materials and joints for prevention of leakage.

The Design of Simple Machine Parts.—Fastenings, bolts, nuts, keys, cotters, rivets and riveted joints. Pipes and pipe joints. Glands and stuffing boxes.

Friction in Mechanisms and Machines.—Friction in sliding and turning pairs. Friction in pivots and toothed gearing. Brakes and Dynamometers.

Lubricants.—Classes of lubricants, mineral, vegetable and animal. Qualities and properties of lubricants; viscosity and oiliness. Testing of lubricating oils. Lubricants for different classes of machinery. Types of lubricators.

Design of Bearings.—Forms and proportions of Bearings. (1) Swivel, (2) Thrust, (3) Footstep, (4) Crank shaft, (5) Connecting rod, (6) Ball and roller. Locomotive axle box. Pedestals, hangers, brackets and wall boxes.

Efforts and Resistances.—Crank effort and simple cases of gyrostatic action.

The Transmission of Power.—Shafts, journals, couplings, pulleys, belts, ropes, and chains. Toothed and epicyclic gearing.

Design of journals, shafts, couplings, pulleys, belts and ropes, and gear wheels.

HEAT ENGINES.

(The Course in Heat Engineering covers thermodynamics and accessories supplemented by Engineering Laboratory work which provides for an extended series of experiments on steam and its properties, steam engines, turbines, compressed air, gas and oil engines, gas producer, refrigerating machinery.)

A. Types of Fuel.—Solid, liquid and gaseous and their advantages and disadvantages.

Solid Fuels.—Wood, Charcoal, Coal, Coke, etc.—Manufacture of Charcoal—Formation, nature and source of coal. Classification of Coal. Carbonisation of coal and manufacture of coke.

Liquid Fuel.—Formation, nature and source of petroleum. Distillation of petroleum and manufacture of petrol, kerosene oil, etc. Manufacture of alcohol and shale oil, benzene, tar oils, atomisers suitable for burning oils under boilers.

Gaseous Fuel.—Natural and blast furnace gases. Manufacture and nature of coal gas, producer gas, water gas, semi-water gas, suction gas, etc. Byproduct recovery plants. Surface combustion of gas under boilers.

B. General.—B.H.P., I.H.P. Dynamometers, Indicators, Mechanical and thermal efficiencies.

Laws of Thermodynamics.—Laws of permanent gases, internal energy and total heat of a gas and vapours. Entropy. Laws of thermodynamics, adiabatic and isothermal expansions and work done during adiabatic and isothermal expansions. Carnot's cycle and principle conditions for maximum efficiency.

Hot Air Engines.—Stirling's engine, Ericson's engine, Joule's engine.

Air Compressors and Motors.—Work done in compressing air in compressors—Adiabatic and Isothermal compressors—Methods of reducing losses—Simple and multistage air compressors—Cooling of compressors—Spray injection and inter coolers—Effect of clearance, efficiency of compressors and motors—Compressed air tools, drills, hammers—Transmission of power by compressed air.

Internal Combustion Engines.—Manufacture of gas, combustion of gases and velocity of flame propagation—Cycles of operation of internal combustion engines, constant volume and constant pressure—Addition of heat—Four stroke and two stroke engines—Effect of strength of mixtures—Ignition—Effect of advancing and retarding of ignition on efficiencies—Effect of compression on fuel economy—Constructural features of several leading types of gas, petrol, oil, Diesel, semi-Diesel and solid injection engines.

Governing.—Quality and quantity of governors.

Dynamics of Engines.—Crank effort, crank effort diagrams, governors and fly-wheels—Balancing of machines.

WORKSHOP THEORY.

1. Pattern-making and Foundry.

Pattern making.—Various timbers used in pattern making allowance in pattern making—pattern maker's tools—joints in the mould and in the pattern—loose pieces—cores and draw backs—principles underlying the construction of rectangular and circular patterns—core boxes, general principles and examples, large and complicated core boxes—strickle boards for cores—complete description of several examples of small, medium sized and large patterns—loam moulding—as it affects the pattern shop—examples of pattern-making for loam-moulding—loam patterns and loam cores—swooping up in green sand and how the pattern making is modified—patterns mounted on plates—plaster and metal pattern plates—patterns for pulleys, toothed wheels, worm gears, screws, etc.—patterns for jobbing work makeshifts—Metal patterns, how to make them—Pattern shop machinery and maintenance.

2. Foundry.—General principles of moulding with simple examples—materials used in moulding—some ready methods of judging the quality of these materials—foundry tools in detail. Dry sand, green sand and loam moulding with typical examples of each class of work—methods of moulding, open—sand, bedding in and turning over—details of moulding—provision made for the support of sand, venting, delivery and mending up, lifters, rods, nails, pouring arrangements, etc.—Cores, uses and manufacture of core boxes—core drying—contraction troubles and some methods of curing them—Errors in design from the foundryman's stand point—slinging and lifting in the foundry—use of chills in moulding.—Brief description of the cupola and its parts—various types and latest developments—The cupola charge—hard and soft mixtures—defects in castings and how to rectify them—Machine moulding—centrifugal castings—Vertical castings.

II. Smithy.

Distinction between smithing and forging—general arrangement of a smithy—the smith's hearth—stock fire and open fire—the blast, centrifugal fans—calculating the pressure of blast from a fan of known diameter and speed—Root's Blower. Tools used in the Smithy. Operations in forging—upsetting, drawing down, setting down, cutting out, bending, punching, drifting, etc. Welding—chemistry of welding—welding heat—forms of welded joints—

butt, scarf and splice welds—stud weld and shaft weld, strength of welded joints—power hammers used in forging—steam hammer, pneumatic hammer, etc.—use of dies in forging—stamping—drop forging.

III. *Machinshop Work.*

1. *Transmission.*—Electric, compressed Air, Hydraulic, Rope, shaft, pulley and belt transmissions.

2. *Making or lining out Tools and Processes.*—Uses of surface plate, scribing block straight tail stock, squares, etc.—method of securing work with clips and bolts, limit gauges, jigs, templates, etc. Fits, Tolerance, etc.

3. *Machine Tools.*—The broad difference between various machine tools in function—difference between rotary and reciprocating tools and the advantages and disadvantages of each—tendency in modern engineering to abolish reciprocation—vertical and horizontal tools—following tools as instances of various types—lathes, plain, screw—cutting, turret, planers, shapers, slotters, drilling machine, boring mill. Automatic machinery—the common features of all these tools—milling and grinding machines.

IV. *Detailed Study of the Machine Tools.*

1. *Lathes in general.*—Bed, headstock, spindle, speed gearing, feed control, carriage, apron tail stock, etc.—cutting speeds—different types of lathes—screw cutting in the lathe—chuck work—turret lathe work.

2. *Planing machines.*—Planer beds, table, housings, etc.—reversing gear—feed mechanism—cutting speed.

3. *Shaping and slotting machines.*—The column, the ram, tool head. Cross rail, table, driving gear, feed mechanism, etc.

4. *Drilling and boring machines.*—Upright drills, Radial drills—multiple drills—speeds and feeds—power required for drills, high speed drilling—characteristics of a drill—several types of drills.

5. *Milling machines.*—Vertical and horizontal milling machines—universal milling machines—description of parts of the Universal Miller. Dividing heads, Index drum, tail-stock, raising block, swivel vice, steady rest and other attachments—characteristic operations—Influence of cutter diameters—assembling cutters, collets, collars, etc.—feed and speeds—cutting action of face, side and end mills,—examples of milling—face milling, slot milling—boring and facing, keyseating and fluting, gear cutting—segment and spot finishing, hobbing a worm wheel, cutting bevel and miter gears, helical grooving milling cutters.

6. *Grinding machines.*—Grinding operations, the dry grinder and attachments—the disc grinder—the wet grinder—universal cutter and reamer grinder—drill grinder—principles and advantages involved in cylindrical and conical grinding—feeds and speeds—lapping—abrasives and abrasive wheels.

V. *Heat Treatment of Steel.*

Theory underlying the heat treatment, constitution of steel, upper and lower ranges of transformation, explanation of hardening, tempering, annealing, case—carburising, chilling etc., by this theory. Consideration of low carbon and high carbon steels. Eutectoid, Hypoeutectoid and Hypereutectoid. Alloy steels, tool steels for high speed work; practical methods of heating, etc., for hardening, tempering, annealing, etc., of these steels.

DRAWING.

(1) Blue Prints of some simple machine parts, viz., pipe and pipe joint, couplings, plumber block—stuffing boxes and connecting rods will be supplied and assembled views of the same will have to be drawn.

(2) Drawings of riveted or toothed joints from their designs.

(3) Preparation of working drawing from sketches of machine and engine parts.

A. *Workshop Practice.*

(Remaining two of the following shops, viz., Carpentry, Fitter's, Foundry and Smithy).

Foundry.—Advanced work in the Foundry, such as the casting of small centrifugal pumps, cylinders of small engines, etc. Practice in machine moulding—casting intricate objects.—Pattern and core making.

Smithy.—Use of Power Hammers for drawing down, welding, forging bolts and nuts, welding head to bolts, preparing keys and cutters, different types of welding—advanced work such as the forging of small crankshafts, connecting rods, hooks, spanners, etc.—Acetylene welding.

Machine Shop.—Plane turning, taper turning, groove cutting, square thread (right hand), dieing, single V-thread, standard bolt and nut—Double V-thread—C. I. Nut—Practice in planing machine and shaping machine involving the preparation of a small plumber block—Brass gear wheel, milling—Turret lathe work.

B. Laboratory.

(1) *Fuels*.—Calorific value of solid fuels—by Lewis Thompson's, Darling and Rosenheim's Colorimeters—of liquid fuels by Darling and Rosenheim's Colorimeters—of gaseous fuels by Boy's Gas Calorimeter—Moisture in coal and oil—Viscometer—Flash Point apparatus—Mechanical equivalent of heat by Callendar's apparatus—Thurston's lubricant tester.

(2) *Theory of Machines Laboratory*.—Velocity and acceleration diagrams, from simple harmonic motion—use of Planimeter.

(3) *Hydraulic Laboratory*.—Calibration of rectangular and triangular notches—Coefficient of velocity, discharge and contraction—Friction in pipes.

ELECTRICAL BRANCH.**BUILDING CONSTRUCTION AND PRINCIPLES OF ARCHITECTURE.**

(As for the Mechanical Branch.)

MECHANICAL ENGINEERING.

General.—Strength, Properties and testing of materials used in machine construction.

Friction.—Friction in sliding and turning pairs, friction in pivots, brakes and dynamometers.

Lubricants.—Classes of Lubricants, mineral, vegetable and animal sources. Quantities and properties of Lubricants. Testing Lubricants. Types of Lubricants.

Bearings.—Laws of Fluid Friction. Tower's experiments, bearing pressure of oils. Design of several types of bearings.

Transmission of Power.—Velocity ratio, friction gear, toothed gear—Simple and compound train, epicyclic gear, bevel gears, worm gear.

Belts and ropes.—Tension in belts and ropes, power transmitted by belts and ropes, velocity, ratio belt and rope gearing.

Shafts.—Design of shafts and couplings.

Thermo-Chemistry.—Fuels, types of fuel—Solid, liquid and gaseous. Their advantages and disadvantages. Carbonisation of coal and manufacture of coke. Manufacture of charcoal and refinement of oil. Theory and use of principal apparatus for determining calorific values of fuels.

Thermodynamics.—The laws of thermodynamics, cycles of perfect gases and vapours. Work done and heat expended in expansion.

Internal Combustion Engines.—Manufacture of gas from coal, coke and charcoal. Theory of two and four stroke engines, oil and oil engines, Diesel and semi-Diesel and other principal types.

Governing of Engines.—Quantity and quality of governors.

Dynamics of Engines.—Crank effort and crank effort diagrams, fly-wheels and governors.

SURVEYING (Theory and Practice).

(Same as for the Mechanical Branch.)

WORKSHOP AND ELECTRICAL LABORATORY.

Electrical and Magnetic Measurements. Determination of high and low resistances. Tests on A. C. and D. C. circuits. Measurements of Inductance and capacity; Measurements of Insulation resistance. Calibration and study of Electrical Instruments. Regulation and Performance, Characteristics and Efficiency tests of D. C. Generators and Motors.

WORKSHOP PRACTICE AND THEORY.

Workshop Practice.—(Remaining two of the following four shops and Machine shop—Carpentry, Fitter's, Smithy and Foundry). Carpentry, Fitter's, Smithy and Foundry—See syllabus for First Examination.

Machine Shop.—Plane turning, Taper turning, Groove cutting, Square thread, V-thread right and left hand—Double V-thread—standard bolt and nut—Practice in shaping and milling machines.

WORKSHOP THEORY.

Use of scribing block, surface plate—Marking and marking out tools—Grinding lathe and Planer tools—Securing work to machine—Use of limit gauges—Fits and tolerance—Lathe and Planer tools, their cutting angle, rake angle, etc.—Feeds and speeds—Study of various types of lathes in general—Lathe mechanism—Planing machine—Quick return motion—Shaping and slotting machine—Types of drilling and boring machines—High speed drilling—Vertical and horizontal milling machines—Dividing head—Milling cutters and influence of cutter diameters—Examples of milling—Grinding—dry and wet grinders—Abrasives—Heat treatment of steel, simple theory.

ELECTRICAL TECHNOLOGY.

Electrostatics—Magnetism—Electromagnetism, Self and Mutual Induction—Properties of Materials, of Conductors and Insulators—Electrical Circuit Laws—Alternating Current theory—Acid and Alkaline Cells.—Principles of lighting and Illumination—Interior Wiring systems and tests—Elementary Theory of Telephony and Telegraphy by wire and by radio communication—Elementary principles of transmission and distribution of Electric Energy.

DIRECT CURRENT MACHINES AND METERS.

Generation of E. M. F.—Wave shape of E. M. F. generated in a coil moving in the magnetic field of dynamo—Rectification of E. M. F. by Commutator—Types of Excitation—No-load saturation curve and applications—Armature Reaction—Necessity for Brush shifting—Interpole, etc.—Performance characteristics, graphical and analytical—D. C. Motors, Types—Performance characteristics, *i.e.*, Speed-load, speed-torque, speed, load, torque and B. H. P. Curves. Stability of Operation. Pull at torque.

Parallel operations of D. C. Machines. Switches and Switchboards. Special D. C. Machines Measuring Instruments.

HYDRAULIC MACHINERY.

Histroy of Water Power Development.—Impact of water on vanes. Work done on a series of vanes fixed to a wheel by impact of a jet. Work done expressed in terms of velocities of whirl of water entering and leaving the wheel. Jet propulsion.

Classification and Theory of Water Wheels.—Overshot, undershot, breast and Sagebein wheels Poncelet wheel. Banky's Turbine.

Classification of Turbines.—Impulse and reaction turbines. Pelton wheels. Girard turbine. Outward flow, inward flow, parallel flow and mixed flow reaction turbines. Design of turbine blades and wheels. Erection and working of turbines. Governing of turbines. Oil and water pressure governors.

Pump.—Classification, theory and design of pumps. Force, lift and gear pumps. Air lift pump. Centrifugal pump. Pulsometer. Humphrey's pump. Boiler feed and Worthington pumps. Erection and management of pumps.

Hydraulic Machines.—Hydraulic presses, riveter, punching and flanging machines, cranes, lifts and hoists, intensifier, accumulator and hydraulic ram. Hydraulic engines, hydraulic brakes.

Hydraulic transmission of power. Joints and packing used in hydraulic work. Consideration of economical diameter and distance of pipe for power transmission.

Testing.—Testing of Pelton wheels, Francis turbine, centrifugal pump, reciprocating pump, hydraulic ram, etc., for efficiency.

MACHINE DRAWING.

1. Blue prints of some of the simple machine parts. *viz.*, pipe, pipe joint, couplings, plumber blocks, bearings and brackets will be supplied and assembled views of them will have to be drawn.

2. Drawings of riveted and other joints from their own designs.

ELECTRICAL DRAWING.

Sketches of details of Electrical instruments and simple Electrical machines, Assembly drawings of D. C. Machines. Detailed dimensioned drawings showing slot details, conductor, and insulation, etc. Same for field winding spools. Armature winding diagrams and schemes. Miscellaneous winding and wiring diagrams of D. C. Machines and accessories. Assembly drawing of an induction motor.

Final Examination in Engineering.

CIVIL BRANCH.

IRRIGATION.

Function of irrigation works and their importance. Natural facilities for Irrigation in India.

Irrigation Systems.—Flow Irrigation, Lift Irrigation, Basin Irrigation and Inundation Irrigation of Upper India, Delta Irrigation of South India, Comparative conditions of Irrigation in the various provinces of India.

Rainfall and Run-off computations from rain gauges for calculations of yield or storage, and waste weir discharges; flood discharge; formulæ for discharge from waste weirs; Dicken's and Ryve's formulæ.

Reservoirs.—Isolated rain fed tanks. Tanks in series. Tanks fed by feeder channels from rivers or streams. Losses of water by evaporation and absorption. Construction of earthen bunds, their maintenance, repairs of leaks and breaches. Tank weirs, their design.

Masonry Dams.—Principles of design, analytical and graphical methods. Gauging river flow for storage and waste weir discharges. Automatic waste weir gates for dams. Stony and other sluice gates. Radial shutters. Smart's shutters.

Anicut.—Pick up weirs thrown across river and principles of their design. Analytical and graphical methods. Head regulators.

Canals and Channels.—Irrigation canals in deltaic and non-deltaic country. Perennial canals. Sources of supply and general characteristics of Indian river. Design of the canal capacity. Alignment, limiting velocities. Location and distribution of canal head works, cross drainage works, weirs, under sluices, head regulators, falls, rapids, locks, diversions, aqueducts, culverts, inlets, crossings, super passages, stop gates, escapes, cart bridges, distributors. Design of the distributory system.

Silt and Scour.—Factors influencing the nature and quantity of river silt. Measurement of quantity of silt; Quantity of silt transported to the sea by the rivers. Silt deposit in reservoirs and tanks. Formation of deltas and characteristics of deltaic rivers. Kennedy's silt theory.

River Training Works.—Spurs, groynes, bell bunds, stream line bunds, mattresses and aprons.

Administration.—Measurement of Discharge. Regulation and duty of water; duty as realised under tanks and under channels, methods of charging for water; module. Block system of irrigation. Financial prospects of schemes.

ARCHITECTURE.

1. *Architectural Design.*—Elements of Architectural form. Theory of Selection. Evolution in Architectonics—plan elevation, construction, form and ornament. Theory of Architectural planning and interior design. Development of Architectural form and styles and composition.

2. *Architectural Construction.*—Mechanics of Architecture, Physics and Chemistry of Materials, Framed Structures, Fireproof Buildings, Trimming and Hardware. Plumbing and Sanitary connections.

3. *Reinforced Concrete.*—(Moulded, Poured Monolithic and Pre-cast) Ornaments and Structural Parts, Treatment of masses and surfaces.

4. *Costing of Materials and Labour.*—Scale and Economy. Standardisation and Repetition.

5. *Interior Design.*—Perspective Effects and Proportion, Acoustics in Public Buildings, Reflection, Preservation and Conduction of Sounds, Reverberation and Resonance, Lecture Theatres and Music Halls, Fenestration and Portalage, Utilitarian Features and Surface Decoration, Sanitation and hygiene; light and ventilation.

6. *Professional Practice.*—Specifications, Estimates and Contracts. Professional Ethics, Clients, Architects and Contractors, Competitions, Schedules, Lumpsum Cost plus piecework and daily Contracts, Quantity and Surveying.

Valuation of Property, Depreciation, Dilapidation, Present Valuation and Expectation of Life Interest and Annuities.

7. *Scioigraphy.*—Shadows and Shading, Presentative Technique and Rendering, Perspectives, graphic and applied. Lettering, monochrome and colour rendering.

Modelling and casting, Freehand Drawing and Sketching. Working Drawings and Drawing from measurements.

8. *Civic Architecture and Landscape Design.*—Civic Engineering, Hygiene and Law. Town Planning, ancient and modern, western and eastern, regular and irregular. Garden and Landscape Design. Remodelling of old work.

RAILWAYS, TUNNELS AND HARBOURS.

(a) *Railway—Survey and Location.*—Railroad surveys and location. General Principles, Conflicting interests, Reconnaissance and Principles of selection of routes. Use of maps. Importance of a good Reconnaissance. Preliminary and Location Surveys. Paper location and Final field location. Organisation of field work. Alignment details: Grades and curves including vertical and transition curves.

(b) *Construction and Operation.*—Construction and maintenance of Earthwork:—formation, Walling, Tunnels, and Culverts for Drainage. Regulation regarding bridges and fixed structures. Use of level crossings. Fencing mile and gradient posts. Permanent way. Gauge of track, Ballast, sleepers, rails, rail joints and fastenings. Laying of the track, super elevation and curves. Use of switches, crossings and turnouts. Design of station yards and sidings. Selection of station sites and approaches. Use of station machinery, signals systems and interlocking. Outlines of Rolling Stock Design, Track maintenance. Renewals and repairs. Effects of curves. Wear of types and rails. Creep of rails.

(c) *Economics of Railroad Management.*—Railroad finances. Operating expenses. effect of minor and ruling grades. Use of virtual profile, humps and sags. Tractive power of Locomotives. Train and other resistances. Pusher grades, balanced grades. Limit of load on wheels and weight of rails. Construction of light railways and street tramways.

Tunnels.—Tunnel Economics. Principles of tunnel surveying and setting out; accuracy of such surveys. Tunnel Design—Cross section, grade, lining, shafts, and drains. Tunnel Construction—Headings, enlargements, different methods of construction, ventilation, portals, and tunnel lining.

Harbours.—General principles governing the design of harbours. Effects of natural forces; Tides, currents, Fetch, exposure, and wave power, Consideration affecting the general design of harbours: natural and artificial types. Design and construction of breakwaters, Signals, buoys, lights, light-houses and illuminations, dry and wet docks, slips. Drainage of Harbours. Problems of harbour improvement.

ROADS AND BRIDGES.

Roads.

A. General economic principles of location, alignment, construction and maintenance of roads with special regard to gradient, direction, geological considerations and drainage, Economics of highway.

Road resistances, traction and ruling gradients; curves, super-elevation for ordinary and motor traffic; Camber on metalled roads. Survey, design, construction and maintenance of metalled roads in plain and hilly country; type cross sections; Iron (steam) and Stone road rollers.

Road Board specifications; Traffic Census; Standard tests for various kinds of road material.

B. Modern Road Construction as practised in England and the European countries and in America. Construction and maintenance of payments for cities.

Railway *versus* motor transport; Effect of wheels and heavy motor cars; Rubber tyres. Economics of motor transport.

Formation of permanent way. Types of roadways.

Camber on modern roads; width of roads; arterial roads and town planning. Hill roads, drainage and ruling gradient.

Wear on roads.—Due to traffic and waves; Pot holes due to heavy speeds; comparison of wood paving, asphalt tar, macadam and concrete; specifications and methods of laying.

Kinds of Roadway.—Tar, bitumin, asphalt and concrete, and methods of using them for road work; specifications and methods of construction.

Cost of maintenance of roads and administration.

Bridges.

General Principles concerning the design of Bridges, Viaducts and Arches of Steel and Masonry.

Preliminary Survey.—Selection of site, location, borings—

Waterways and determination of discharges of rivers with reference to area of watershed; intensity of rainfall and by zoning. Depth of scour during floods.

Foundations.—Box, crate, well, pile, mass and reinforced concrete slab; coffer dams. Design of piers and abutments. Protection of banks and abutments during floods.

Types of Bridges.—Steel bridges, and masonry arches. Rolled I beam bridges; plate girders and simple truss bridges of the Deck and Through type; their economical spans; arrangement of main girders; systems of flooring; connection of cross to main girders, etc. Warren and simple lattice girders. General considerations in the design of suspension, cantilever, swing and steel arch bridges.

Masonry Arches.—Design of abutment and piers; the elastic theory and methods of tracing the curve of resistance for various conditions of loading; centres and their design and method of lowering centres. Arches of the parabolic, elliptic, semi-circular and segmental types.

Shore protection, rivetment; Aesthetics and economy in design; outline of span, symmetry, scale or proportion of parts.

Theory of elastic deflections and outlines of investigation of stresses in R. C arches.

DRAWING (Railways, Irrigation Bridges, Etc.)

The course is intended to familiarise the student with the making up of the drawings necessary in the preparation of official projects and engineering contracts and also the drawings and details requisite for the actual execution of engineering works, both constructional and mechanical, the usual scales for such drawings and the information to be contained in them.

Candidates are required to produce to the Examiners original drawings made by them in the College and certified as their work by the members of staff under whom they have received training, and to answer questions put by the Examiners on such drawings.

Drawings from given data for works connected with Railways and Bridges such as bridges of steel and masonry arches, and irrigation works such as aqueducts, super passages, syphons, drops, head regulators, locks, etc.

STRUCTURAL DESIGN.

A general review of Applied Mechanics and Graphic Statics and applications of Principles to Engineering Structures by Analytical and Graphical Methods.

1. *Principles of Economic Design.*—Factors of Safety, Live Loads, Working Stresses, Wind Pressure. Analytical computation of stresses in roof and simple bridge trusses, Arches and Suspension Bridges.

Design of Buildings.—Principles of economic designs of residential and public buildings and factories with special reference to selection of site, construction of walls, damp proof courses, water supply, drainage and ventilation. Fire proof construction. Reinforced brickwork design. Columns and their foundations. Safe bearing power. Brick piers, grillages and foundations for buildings. Practical consideration in selecting type of columns. Practical details of connections, caps and bases.

Design of Roofs, Types, Proportions, Spacing of Trusses.—Weights of roof coverings and trusses. Standard formulæ. Types of roof trusses. Working drawings for steel trusses of various types. fixing of ends, gusset rivet, connections for trusses. Standard types of joints.

Bridges.—Steel:—classification of braced structures. Application of the theory of bending due to load of Traction Engines, Locomotives and Trains.

Design of Steel Bridge Girders.—Economic types of bridge girders. Economic spans. Arrangement of main girders and flooring. Working drawings of various types. Standard types of connections cross girders to main girder; and other connection.

Plate and Box Girders.—Area and curtailment of flanges, flange splices, thickness of web plate stiffeners, pitch of rivets, lateral bracing, connection of cross girder to main girder; systems of flooring; pin connection and riveted bridges.

Lattice Girders.—Types and spans, for which suitable: open web girders. Stresses in parallel girder and girders of varying depth. Counterbracing, web bracing and connections. Floor systems and rail bearers. Practical details of design and construction. Cross section of beams, End posts, expansion and pin bearing, etc.

Miscellaneous Structures.—Crane Jibs riveted steel tanks. Tall buildings. Details of construction and wind bracing.

Earth pressure.—Rankine's formula, Rebhan's method. Design of retaining walls. Types of retaining walls. Stability of masonry dams, arches, piers, chimneys.

Tall Chimneys and Towers.—Effect of wind pressure and detailed design of chimneys.

Reinforced Concrete Structures.—Theory and design of reinforced concrete columns and piles. Detailed designs of simple T-beams, floors, cantilever and counterfort retaining walls, dams and arches. Reinforced concrete floor systems, columns and footings. Complete design of a typical cross section of a building, including corner columns, stairs and floor openings. R. C. elevated tanks.

STRUCTURAL DRAWING.

1. A detailed knowledge of standard structural steel shapes and sizes used in structural design and their drawing.
2. Typical shop drawing of the structural frame work of steel used in buildings and other structures excepting those that come within the province of the first drawing paper.
3. Detailed design of buildings of varied character to satisfy varied requirements and in conformity with principles of architectural composition.
4. Preliminary sketches to suit a given programme of specifications and requirements with a view to develop into finished working drawings.
5. Stability diagrams of structures.

TESTING LABORATORY

This course is given in conjunction with the course on structural design and includes practical tests to determine the physical properties of materials of construction.

I. Tests to aid in specification of various varieties of stones and bricks, timber and steel for buildings. Simple tests for limes, cements, mortars and tests for road material. Physical test for specific gravity, porosity, elasticity, adherence; absorption, percentage of water, hardness, abrasion, crushing stress, solubility and weathering properties of various building stones and brick. Experiment for specific gravity and crushing strength of various kinds of stone and brick masonry.

Tests in sand for presence of loam, clay and salts. Void Tests.

Conducting experiments with various samples of brick, earths, sands, etc., obtained from various parts and different proportioning of ingredients for bricks and trying tests for strength.

II. Limes, Mortars and Cements.—Conducting simple tests for specific gravity, strengths under tension, compression and shear for various proportions and variation in time of setting.

Capacity for increase in volume of mortar yield per unit quantity of lime by mixture with sand and study of the materials used in concrete, both plain and reinforced, the selection of proper aggregates; their treatment for various purposes and methods of proportioning.

III. Timber.—Test for density, specific gravity, moisture content, percentage of sap and hard woods: Smell, sound and tissue examination of a cut piece

Tests for tension, compression and shear and transverse strength treated with chemicals.

IV. Road Materials.—Testing road material for toughness and abrasion. Grading of material into sizes and void tests.

V. Photography.—Manipulation of the Cameras. Focussing, loading and unloading of Films and Plates. Exterior and Interior Views. Time and Instantaneous. Development of Films and Plates. Printing and toning of P.O.P. and Bromide Papers. Glazing, Trimming and Mounting, Preparation of lantern slides.

ESTIMATING, SPECIFICATIONS AND ENGINEERING ECONOMICS.

Methods of taking out and scheduling quantities and costs for Engineering works of various kinds such as buildings, culverts, bridges, sluices, waste weirs and irrigation works. Drawing out specifications in regard to the qualities of materials and tests prescribed in Engineering contracts. General principles for working out the costs of the several items in an estimate.

Productive and protective works. Drawing up of departmental reports. Systems of accounts. Contracts, Capital and Revenue.

Earthwork.—Definitions, Contracts, Stability and angle of repose of soils; measurement and setting out. Instruments used. Section and Volumes. Drainage, Puddling, Consolidation, Dressing and Turfing. Rates, Lift and Lead.

General conditions of Contract and their bearing on the responsibilities of the Engineer Contractors and the Principals. The nature of the specifications in regard to the qualities of workmanship and tests prescribed in Engineering contracts.

Engineering Economics.—Fundamental Economic Principles; Problems of Production, Consumption and Distribution and Value in exchange of Wealth. Engineering Services, Cost of Preparation and Service. Fixed Charges and Operating Costs; Profit.

Economic Selection.—Investigation, Financing and Construction of Structures.

Elements of Accounting.—Significance of Double Entry, Assets and Liabilities, Goodwill, Financial Statements, Balance Sheets, Valuation, Depreciation, Dilapidation.

Business Administration.—Industrial management, Plant Location, Equipment, Organisation and Management.

SURVEYING (Theory and Practice.)

GEODETIC SURVEYING.

1. Study of other Surveying Instruments such as the Zeiss and Precision Levels. The Tacheometer. The Gradiometer. Photo Theodolite, etc.
 2. Review of the adjustments of all the Surveying Instruments.
 3. Errors in Surveying. Principle of the method of least squares. Probable errors. Survey adjustments and Geodetic Computations.
 4. Triangulation and Trigonometric Levelling. Major and Minor Triangulation and finding of heights and distances. Errors in such surveys and their elimination. Adjustment and calculation of direction. Figure of the earth.
 5. *Tachometric Surveying*.—Introductory Principles. The Stadia system and the constants of the Tacheometer. Analytic lens. Field work and records of field work. The tangential and other systems of surveying. Principle and use of Range finders. General hints on securing accuracy.
 6. *Underground Surveying*.—Tunnel and Mine Surveys. Connection of surface and underground surveys. Instruments used and methods of using them.
 7. *Hydro-graphical Surveying*.—Scope. The tides and gauges. Shore line surveys. Methods of Sounding. Surveys of tidal currents. Stream measurement.
 8. *Geodetic Astronomy and Astronomical Surveying*.—Necessity for astronomical observations. The celestial sphere. Astronomical terms used. The Nautical almanac. The purpose of observations. Instruments used. The artificial horizon. The prismatic astrolabe and the solar attachment. General procedure, determination of time, meridian, latitude and longitude.
 9. *Measurement of Areas and Volumes*.—Systems of calculation. The Planimeter and its uses. Prismoidal and curvature corrections. Volumes by spot levels and contours. Mass diagrams and calculations of haul and overhaul in earthwork.
 10. Several methods of setting out of curves. Vertical and transition curves. Compound and reverse curves. Diversions.
 11. Surveys for Engineering projects such as roads, railways, canals, water supply, irrigation and sewerage. Hydro-electric surveys.
- Project Surveying*.—A special project survey should be undertaken during the final year course and the necessary records, calculations and plans submitted.

MECHANICAL BRANCH.

HEAT ENGINES.

Properties of wet and superheated steam and vapours—heat—external work done—internal energy—Calendar's experiments and equations—Throttling—Entropy: Entropy-temperature chart—Mollier Diagram—Total heat-pressure diagram—Calculations of dryness fraction, total heat and available heat drop.

Theory of steam Engine.—History of early types of engines—Newcomen engine—Watt's Principles—Expansive working of steam—Watt's engines—Rankine cycle—Efficiency of engine working on Rankine's cycle—Effect of clearance and cushioning on efficiency—effect of using superheated steam—Losses in actual engine due to wiredrawing etc.—Steam jacketing—Methods of reducing losses—Advantages of compounding and multiple expansion—Ratio of cylinder volumes—Effect of receiver—Indicator card—Diagram factor.

Turbines.—Heat drop—Velocity of steam at throat and exit of Nozzles—nozzle designs—Injectors—Design of nozzles for Impulse turbine—Compounding of impulse turbine—Velocity compounded, pressure compounded and velocity and pressure compounded—Cross compound turbines—Reaction turbines—Parson's Lunjstrum and other types—Design of blades and drums.

Condensers.—Heat transmission through flat plates and tubes—Effect of vacuum on efficiency of engines and turbines—Construction and maintenance of several types of condensers—Jet, Barometric ejector and surface condenser—Air pumps—Vacuum augmentor.

Boilers.—Efficiency of flat plates—construction of boilers—types of boilers—Lancashire, Cornish, Babcock and Wilcox, Sterling, Yarrow, Locomotive, Portable, Marine, and vertical boilers.

Stokers.—Mechanical stokers and other auxiliaries.

Governing of Engines.—Several types of governors—Throttling and cutt off governors for engines and turbines.

Valve Gears.—D-slide valves, Piston valve, Corliss, Drop, Allen, Mayer's expansion valve and other valves.

Valve Diagrams.—Piston displacement curves—Rectangular, Oval, Reuleaux, Zeuner, Bilgram diagrams.

Link Motions.—Link motion gears—Stephenson, Gooch, etc.—Radial valve gear—Hackworth, Joy's, Marshall, etc.

Testing of Engines, Boilers, etc.

Mechanical Refrigeration.—Properties, of vapour; Ammonia, Carbon dioxide and Sulphur dioxide—Choice of a refrigerating agent—Coefficient of performance—cold air machine—Types of Vapour Compression machine—Horse power required—Design and erection of cold storage rooms and refrigeration plant.

Testing.—Testing of fuels, Power Plants, Air Compressors and refrigerators.

HYDRAULIC ENGINEERING.

Power Generation.—Brief history of water power development. Impact of water on vanes. Impact of water on a vane when the directions of the motions of the vane and jet are not parallel

Conditions which the vanes of hydraulic machines should satisfy. Work done on a series of vanes fixed to a wheel expressed in terms of the velocities of whirl of the water entering and leaving the wheel. The propulsion of ships by jets of water.

Water Wheels.—Classification and theory of water wheels. Gravity, overshot, undershot. Breast, Sagebein, Impulse and Poncelet wheels.

Turbines.—Classification and theory of turbines. Reaction turbines, outward flow, mixed flow, inward flow and parallel flow turbines. Impulse wheels, Girard turbine and pelton wheel. Design of turbine blades, rotors and casings. Regulation of turbines, oil and water pressure governors. Erection and working of turbines.

Pumps.—Classification and theory of pumps, Centrifugal pumps, Reciprocating pump, Boiler feed pump, Worthington high duty pumps, pulsometer pump, Humphrey's internal combustion pump, Air lift pumps, gear pumps. Design of blades, rotors and casings of centrifugal pumps, design of simple force and other pumps. Erection and management of pumps.

Hydraulic Machines.—Forging press, Hydraulic press, Hydraulic riveter, Hydraulic lifts, Cranes, Double power Cranes, Hydraulic engines.

Hydraulic Transmission of Power.—Accumulators simple, differential, and air accumulators. Intensifiers, hydraulic and steam. Hydraulic water mains. Transmission of Hydraulic power in mains, losses and efficiency in Hydraulic power transmission. Joints, and packings used in Hydraulic work.

Testing. Testing of reaction turbine, pelton wheel, centrifugal pump, plunger and boiler feed pumps, hydraulic ram, pulsometer pumps.

POWER PLANT ENGINEERING.

Economics of Factory Construction.—Factors influencing the general and exact location of a Power Plant to be co-ordinated in economic production.

Design.—Lay out and Arrangement of Buildings for Power Plants, Types of Industrial Buildings, Power Houses, etc. Details of the Trusses, Roofing, Walls, Ventilation, Lighting, Flooring, etc., in the various shops. Arrangement and Operation of the equipments in Power Plants; Simple Applications of these Principles to small layouts like a Smithy, Foundry, a Machinshop, a Carpentry, etc.

Economics of Power Transmission.—Comparative cost of working data about the various forms of Power Transmission and their special adaptabilities: Conveyers, Elevators, Travelling Cranes, Ropeways, Runways, Hoists, etc.

Economics of Power Generation.—Choice of Power; Comparative Economic data on Power and the special features of the various forms of Power. Capital and operating costs of the different kinds of Power.

Design, Location and arrangement of Power in Power Houses.—Auxiliaries for the various kinds of Power installed e. g., the Pumping, circulating, condensing, superheating, feed-heating, softening, fuel-supplying, etc., accessories needed for a certain Power Plant of a known capacity.

General items to be considered for the increase in the economic efficiency of Power Generating Plants.

General ideas of the Operating Establishment in Power Houses and the maintenance of Log Books and other details of supplies, waste, lubricants, etc. needed therefor.

LABORATORY.

The course provides for an extended series of experiments on steam and its properties, steam engines, compressed air, gas and oil engines, Gas producers, steam turbines, refrigerating machinery, hydraulic pumps, water wheels and turbines and devices for mechanical transmission of Power.

Steam Engines Laboratory.—Testing Low Pressure and High Pressure Boilers—Tests on Donkey Pump, Pulsometer.—Horizontal and Vertical Steam Engines—Bellis and Morcom High Speed Engines—Triple Expansion Engines—Steam Turbines, Testing of Indicators and steam meters.

Internal Combustion Engines Laboratory.—Tests on National Gas Producer and Gas Engine, Two stroke Diesel engines, Four stroke Diesel engines. Kerosine Engine, Ammonia Refrigerator.

Hydraulic Laboratory.—Tests on Hydraulic Ram,—Various types of Pumps, single and multistage centrifugal pumps, Pelton wheel, Francis turbine, etc. Testing of various types of meters.

Strength of materials Laboratory.—Testing Cast Iron, Wrought Iron, and Mild Steel, Brass, Copper, etc. for tension, compression, shear, torsion and bending. Bricks and Tiles testing, Cement testing, Stone testing, Wire Rope Testing, Ball hardness testing.

Theory of Machines and Applied mechanics Laboratory.—Verification of various laws of force and motion.

WORKSHOP PRACTICE.

Advanced work in the Lathe, Planing, Shaping and Milling Machines, involving the preparation of small Engines of Machine Parts—Complete design, preparation—Machining and fitting up of a small Engine or Pump.

MACHINE DESIGN.

(a) *Design of High Speed Shafts.*—Whirling of shafts, critical speed of shafts, shafts for centrifugal pumps and steam turbines, turbine discs and impellers. Thrust blocks for high speed shafts and propellers. Design of steel and iron tanks.

(b) *Design of Machines, Internal Combustion Engines and Steam Engine details.*—Design of pistons and piston rods, connecting rods, cross heads and slides, engine eccentrics, stuffing boxes, glands, fly-wheels, steam engine governor, valves, cocks, and sliding valves, condensers, steam engine valves.

Design of machine frames, chains and crane hooks, springs, machine handles.

(c) *Design of Boilers and Boiler details.*—Design and construction of boiler shells, flues and tubes, manholes, safety valves, blow offs, furnaces, fire grates, fire bridges and fire bars, feed water tubes, chimneys, steam pipes, superheaters.

ESTIMATING, SPECIFICATIONS AND ENGINEERING ECONOMICS.

Estimating of the costs of simple machines like the drilling and the slotting, soapmixtures, plodders, simple presses, pumps, etc., of steel framed structures for Railway and other purposes: stagings; elevated tanks; trusses for the various engineering shops, etc.

Costs of small shops provided with shafting, countershafting, helting, pulleys, bearings, small machine tools, engine or motor drives, etc., inclusive of the housing of the machinery and their fixtures.

Costs of small simple boilers like the vertical, the doghouse, the smoke tube, etc.

Costs of Pipelaying and jointing for raising mains, etc., in cast iron, rivetted or spigot and socketted steel and for galvanised iron, water piping, gas pipe work, etc.

2. *Specifications* for the materials used in the construction of the above and also for the simpler built-up appliances quoted above, for example, the steel trusses, boilers, bearings, shafting and columns, etc. Standard specifications as per British practice of some of the more important materials of construction, e. g., of boiler construction structural work; casting for various uses like pumps cylinders, pistons, pressure pipe lines, etc.

Methods of drawing up of reports, tenders, contracts, etc., for engineering works.

3. *Engineering Economics.*—Costs and costs-keeping, methods of framing costs in the various shops. Materials, direct labour, indirect expenses like the fixed charges of interest, etc., on land, building, fixtures, insurances taxes, etc., and the general burden made up of non-productive labour, cost of power, lighting, heating, depreciation and maintenance of buildings and plant, establishment and supervision and also the burden on idle machines in the power plant.

Costs of small power plants with the buildings and layout of equipment, etc.

Cost of Power Per H. P. per Year.

Methods of depreciating Old Plants, salvage values, Scrap values; Valuation, etc.

Stores, Stores Management, Stock Books, Tools and Plant Books, Indents, Warrants, Issues Invoices, etc.

Time Keeping.—Job-time accounting; Instruction Cards; work-men's pay books, workbooks, etc.

Wages.—Piece work, Task work, bonus, etc. Systems of payment.

Profits and profit sharing. Methods of arriving at total costs.

MACHINE DRAWING.

More advanced Practice in drafting work.

Each student is furnished with blue print details of some machine or portion of a machine, and he is required to make an assembly drawing of the same. He is thus given practice in reading drawings and building up a general drawing from details. Drawing from their own design and their lay out. Instruction is also imparted in the various processes of printing and copying drawings, etc., such as blue printing, Photography, Enlarging, lantern slide making.

ELECTRICAL ENGINEERING.

D. C. Dynamos and Motors, Types, Theory, Characteristics and applications. Parallel operation of Generators. Special D. C. Machines—Switches and Switchboards.

Alternating Current Generator—Theory and Performance. Characteristics. Regulation of Alternator. Synchronous Motors, Theory and Operation. Application for Power factor correction and voltage regulation. Transformer, Theory, Operation, Regulation and Construction. Single and poly-phase connections. Induction Motors. Theory and Operation. Induction Generator.

Synchronous Converter (Same as for Electrical).

Parallel Operation of A. C. Generators.

Specification of Insulators and Insulated Conductors and Cables. Heating and Construction of the same.

Comparison of C. C., Single and Polyphase. Systems of transmission of power. Voltage drop and regulation of transmission lines. Generation and Distribution.

Switchgear and Station Equipment.

Faults and Networks, Location.

LABORATORY.

Tests on D. C. Generators and Motors. Regulation tests on A. C. Generator. V-curves of synchronous Motors. Commercial Tests on Induction Motors. Voltage ratio and efficiency tests on synchronous converter. Regulation and efficiency tests on transformer. Calibration of Measuring Instruments.

STRUCTURAL DESIGN.

(Same as for Civil Branch.)

ELECTRICAL BRANCH.

ELECTRICAL ENGINEERING.—I.

Armature Reaction.—Flux distribution in the air-gap at no-load and under load condition. Necessity for Brush shift on load. Ratio of armature reaction to no-load Field Ampere turns.

Commutation.—Methods. Reactance Voltage. Brush contact resistance. Sparking voltage. Limits of armature loading. Interpoles. Compensating winding.

Tests on D. C. Machines.—For losses and efficiency and separation of losses. Systems of Excitation of D. C. Machines. Regulation and performance characteristics derived both graphically and analytically. No-load saturation curve and its applications. Building up of voltage of a shunt generator. Effect of Speed variation on voltage of machine. Stability.

D. C. Motors.—Production of continuous torque in a D. C. Motor. Types of Motors. Operating characteristics derived both graphically and analytically. Speed-torque, H. P. Speed, Curves, etc. Efficiency. Starting and regulating switch-gear. Calculations.

Parallel Operation of D. C. Generators.—Necessary conditions. Division of load. Equalizer connections in the case of Compound-Wound generators. Switch board arrangement for the last case.

Special D. C. Machines.—Three-wire generators. Balancer and balancer set. Balancers and Boosters. Booster and Battery. Battery switches and switch boards. Rosenberg Dynamo. Traction by continuous current. Solution of Simple case. Elementary ideas of Electroplating and Electro-metallurgy. Secondary cells; charge and discharge curves.

Transformer.—Relation between voltage, current and flux in a transformer. Steinmetz equivalent circuit and solution of transformer by this method. Mutual and leakage fluxes in a transformer. Behaviour of flux in a transformer under load. Mechanical stresses in a transformer on short circuit. Hysteresis and Eddy losses. Single phase transformers connected γ and Δ for three phase work. Three-phase transformer, shell and core type. Open delta and scott connection of transformers. Auto-transformer and compensator. Dissimilar transformers in series and in parallel.

Wave distortion in transformers.—Triple frequency and voltage and current Components in different transformer connections. Maximum flux comparisons in a flat-topped and sine wave voltage. Trapezoidal wave, maximum and effective E. M. F. form factor. Determination of flux waves corresponding to distorted voltage waves. Exciting current wave shapes in transformers. Exciting current required for a given voltage wave. Effect of wave form of magnetizing current on core losses. Operation of transformers in poly-phase systems. Effect of unequal voltage ratios in parallel transformers. Effect of unequal impedances in transformers connected in parallel. Three-phase to two-phase and *vice versa* transformation. Three-phase to six-phase transformation.

ELECTRICAL ENGINEERING.—II.

Alternator.—Single phase alternator, armature reaction, disadvantage. Poly-phase alternator, armature reaction, Vector Diagram. Synchronous reactance. Maximum Power. Phase Voltage-Harmonics. Regulation. Relation between terminal voltage, power output, excitation, power factor and angle of displacement. Leakage reactance of alternator. Short circuit of alternators and mechanical stresses.

Synchronous Motor.—Reactions in a synchronous motor. Vector diagram. Performance Characteristics. V-curves, Power factor correction. Stability of Operation.

Parallel Operation of Alternators.—Division of Load. Synchronising current and Power Hunting. Methods of prevention of Hunting.

Synchronous Converter.—The alternating E.M.F. of a closed D. C. Winding. Voltage and Current ratios for different types of Converters. Armature reaction. Heating and Capacity. Voltage variation, use of reactance coils. Regulating pole converter. Converter with series booster. Connections, etc. of sixphase converters for Edison three-wire system D. C. Distribution. Commutating Poles. Inverted Converters. Operation of converters in parallel. Hunting. Power Factor Correction. Comparison with synchronous motor generator sets.

Polyphase Induction Motor.—Production of a rotating field. Necessity for the motor to slip under load. Proof of the circle diagram and determination of the various quantities like power, torque, power factor, in-put current, slip, etc. from the circle diagram. Analytical solution of the Induction motor. Effect of change of frequency, voltage and air gap on the performance characteristics of the Induction motor. Rating of motor when γ connected motor is Δ connected and *vice versa*. Motor with auto transformer. Speed control and power factor correction of Induction Motors. Induction motors in cascade. Use of phase advancers with Induction motors. Induction generator.

Single Phase Induction Motor.—Theory and Performance Curves, Phase Conversion.

A. C. Commutator Motors.—Principles, Operation and uses of different types of single phase Commutator motors. Applications of three-phase commutator motors.

Lighting, Illumination, Photometry. Incandescent and arc lamps.

Frequency Converters, Regulators. Rectifiers.

A. C. Electrical Instruments:—Principles, Operation, Use and Calibration.

Measurements of Capacity, Inductance and resistance.

GENERATION, TRANSMISSION AND DISTRIBUTION.

GENERATION AND CONTROL OF POWER.

Principles of Net-work design.—(D. C.) Position of Central Station and feeding points. Determination of cross sections of feeders and distributors. Design of Feeders. Calculation of distributors and feeders. Special arrangement of feeders. Net-work analysis. Power net-works, three-wire net-works. Voltage drop and Power loss in feeders, distributors and net-works.

A.C. Single and Polyphase networks.—Solution of Circuits containing resistance, capacity and Inductance. Symbolic and Vector methods in transmission line calculations with lumped constants. Resonance. Problems in electrostatics. Calculation of the performance of H. T. long distance.

transmission lines, with lumped and distributed constants, Effect of sub-division of conductor on the spacing of wires. Regulation and stability of transmission lines.

Insulators for transmission lines.

Estimation of small power transmission systems.

Sub-station equipment, general layout and estimation. Station switch-gear and control.

Power cables and their construction Graded cables. Heating of cables. Cost and installation cables. Concentric and three core cables. Capacity of cables. Voltage stress in cables.

Voltage regulation and power factor control of transmission systems by the use of synchronous motors.

Economic limits to power factor correction in a system. Effect of voltage and frequency on the economics of a transmission system.

LABORATORY.

Calibration of electrical instruments. Tests on storage battery. Determination of faults in networks. Measurements of resistance, capacity and inductance. Determination of the performance characteristics, regulation and efficiency of D. C. generators and Motors. Separation of losses in D. C. machines. Temperature rise measurements in D. C. machines. Laboratory and commercial tests on A. C. generators, Synchronous motors and synchronous converters. Parallel operation of A. C. and D. C. generators and converters. Power and energy measurements in electric circuits. Open circuit and short circuit and heat run tests on transformers and calculation of their regulation and efficiency. Parallel operation of transformers. Variation of core loss with impressed voltage and frequency and separation of core losses. No-load and locked rotor tests on Induction motors. Circle diagram and derivation of the complete performance characteristics from the circle diagram. Induction generator. Operation of different types of A. C. motors and their efficiency test. Tests on wave form of alternating currents and voltages.

THEORY AND DESIGN OF ELECTRICAL MACHINES.

(A) D. C. Dynamo.

1. Armature Winding Schemes.

Magnetic Circuit.—Leakage Factor—Magnetic Path—Fringing Constant—Calculation of the no-load Saturation Curve.

3. *Design of the Magnetic Circuit.*—Design of the Field System—Size of Field Wire—Field Coils and heating.

4. *Heating and Temperature.*—Methods of Ventilation.

5. Insulation of Machines and Construction details of Armature, Pole, Yoke, Commutator and Bearing.

6. Efficiency and Losses.

7. Armature Design.

(B) Transformer.

Magnetic Leakage; Core Type with two coils per leg, with split Secondary Windings and Shell Type. Alloyed Steel Laminations. Influence of Dimensions on the Output. Weight of active iron Losses, Efficiency and heating. Theory of Heating and Cooling. Construction of Transformers—Transformer Insulation—Design, Procedure and Transformer Design problems.

(C) Alternator.

Windings.—Fundamental Diagrams. γ and Δ Connection, Multi-conductors per slot. Full pitch and Chorded windings (Phases overlapped).

Construction of Alternators.—Stator—Poles and Field Ring. Insulation.

Design of the Revolving Field System.—Field Excitation. Calculation of the Saturation curves. Losses, Efficiency and Heating. Design, Procedure.

Special Alternator Problems.—Flywheel design—Design of Dampers—Design of Synchronous Motors.

Alternator Specifications; Examples; Effect of Voltage and speed on efficiency.

(D) Polyphase Induction Motor.

Construction of Induction Motors, Stator and Rotor. Rotor Slot Design. Calculation of the no-load losses.

Leakage Reactance.—Leakage Fields—Zig-zag Reactance—Belt Leakage.

Copper Losses.—Conductor and end Connector losses.

Heating of Induction Motors.—Heating and Cooling Curves—Intermittent Ratings—Stator and Rotor Heating—Effect of Construction—Enclosed and semi-enclosed motors.

Noise and Dead Points in Induction Motors—Windage, Noise—Pulsations of the main field—Leakage field variations—Dead points at starting.

Design Procedure.—Output Equation—Design of Squirrel Cage and wound rotor motors—Windings for different voltages. Induction Motor Specifications.

ESTIMATING, SPECIFICATIONS AND ENGINEERING ECONOMICS.

Estimate and Specifications.—Drawing out detailed standard specifications and taking out rough estimates of cost of small power transmission systems and low voltage distribution systems, etc., including Power Equipment, Lighting and Heating in Industrial plants and for Industrial purposes.

Economic of Hydro-Electric Power Supply.—Dams Flash boards, Fishways and Intakes, design and cost estimates. Water Conductors, water hammer and surge tanks and gateways and valves.

Storage reservoirs. Power House Design, Building, Arrangement of Apparatus, Transportation and Erection and "Starting up" of the Station. Hydraulic Equipment. Electrical Equipment.

Economics of Power Transmission and Distribution at High Voltages and low Voltages (A. C. and D. C.).

DRAWING.

A. Sketches of Details of (i) Electrical Instruments, (ii) Various Parts of Rotor, methods of mounting them, (iii) Various parts of Stator of electrical machines. Sketches of slip rings and other details connected with them. Sketches of Field Coil details, insulation, support, etc. Sketching of Details of various types of Transformers.

B. Assembly Drawings with complete winding diagrams, etc. of (i) an Alternator, (ii) of Rotary Converter, (iii) of Transformer,

C. Switchboard and Control wiring diagrams. Station lay-out. Section of Power House.

D. Photography.—as for the Civil Branch.

STRUCTURAL DESIGN

(Same as for the Civil Branch.)

MECHANICAL ENGINEERING.

1. Properties of Steam—Generation of Steam at Constant Pressure—Total Heat—External work done—Change in the internal energy—Super-heated steam and its properties—measurement of dryness fraction after expansion—Mollier and Total heat-pressure diagrams.

2. Generation of Steam—Boilers—Types of Boilers—Vertical smoke tube and Water tube boilers—Super heaters—Economiser—Feedwater heaters—Air heaters—feed pump injectors.

3. Theory of steam engine—Steam engine working on Carnot's and Rankine's cycles—Temperature—Entropy diagram for Rankine's cycles—Effect of using super-heated steam—Effect of clearance on mean effective pressure—Actual Indicator diagram—Wire drawing and cushioning Initial condensation and re-evaporation—Missing quantity—Valve leakage—steam jacket—steam consumption, the Willan's law—Effects of compounding on steam consumption and efficiency.

4. Theory of Turbines—Flow through nozzles—Design of nozzles—Function of a Turbine—Impulse and reaction turbines—Compounding of turbines—velocity and pressure compounded turbine—cross compounded turbines—Exhaust turbines—Effects of pressure, superheat and vacuum on efficiency—Governing of Turbines.

5. Mechanical Refrigeration—Properties of Vapour—Ammonia, Carbon dioxide and Sulphur dioxide—Choice of a refrigerating agent—Coefficient of performance—Cold air machine—Types of Vapour Compression machine—H.P. required.

6. Testing of Power Plants for efficiency.

LABORATORY.

1. *Fuels*.—Determination of calorific values of solid, liquid and gaseous fuels—Viscosity and flash—Mechanical Equivalent of Heat.

2. *Heat Engines*.—Testing of Low Pressure and High Pressure Steam Engines—Bellis and Morcom high speed Engine and triple expansion Engine. Gas and Oil Engines.

3. *Hydraulic Laboratory*.—Flow through notches—Coefficients of Velocity, discharge, contraction, etc.—Friction in Pipes—Hydraulic Ram—Pelton wheel, Francis Turbine, etc.

4. *Strength of Materials*.—Testing properties of Materials along with the Mechanical Engineering students as in the Mechanical Engineering syllabus.

WORKSHOP.

Machinshop.—Machining small objects or engine parts on the lathe—Use of Planing and Shaping Machines—Milling a gear wheel.

Physical Culture

Regular work in physical education is required of all students who are physically fit during the four years' course at the College. Seventy-five per cent attendance is necessary in this as in other subjects. Regular members of the teams in any of the inter-collegiate sports receive due credit in physical education for time spent in this way. Such exercises must, in order to receive credit, be regular and must be certified to by the Secretary for Sports.

In-door Work.

First Year.—Systematic and progressive training in calisthenics and drills; standard dumb-bell drills of simple movements; elementary apparatus work with emphasis upon exercises of an athletic nature; instruction in group games and game contests. Most of the year's work consists in setting up exercises as all important in promoting the health of the student.

Second Year.—Standard drills—advanced—with dumb-bells, wands and Indian clubs. Gymnastics apparatus work with emphasis on neat work, games, basket balls, volley ball, hand ball and a continuation of the games of the first year.

Third and Fourth Year.—Class work in wrestling and boxing.

Special Gymnasium Work.—Corrective exercises are given to those who are below normal physically. Suitable exercises will also be given for those who desire special development of various parts of the body. Special exercises are also given to students having physical defects which debar them from the regular courses.

Out-door Work.

Foot-ball, cricket, hockey, tennis and other group games, and also cross-country and long distance running. Inter-class matches and races will be held at stated times during the year.

APPENDIX I.

SCHEME OF THE ENDOWMENT BY MR. B. L. NARSIMHAIYA, B. A.

I. A scholarship of the value of Rs. 90 per annum to be called the "**Bhagavatha Lakshmi Narasimhaiya Gowramma Scholarship**" will be instituted out of the proceeds of the Endowment.

II. The scholarship will be paid in two half-yearly instalments in July and January each year.

III. The scholarship will be awarded in the II year L. M. P. class of the Government Medical School, Bangalore, to the Brahmin student passing the First L. M. P. Examination, who, in the opinion of the School Council is the most deserving on grounds of poverty and merit and who does not get any other scholarship or stipend.

IV. If there is no student deserving of the scholarship on grounds of poverty and merit among the students passing the First L. M. P. Examination, it may be granted to the most deserving poor Brahmin student who passes the II or III L. M. P. Examination provided he is not in receipt of any other scholarship or stipend.

V. The scholarship once awarded, to a student may be continued to the same student till he completes his final year's course in the Medical School, subject to satisfactory progress and conduct.

VI. If the progress of the student is affected from causes beyond his control—such as illness—the scholarship may be continued to him if, in the opinion of the School Council, such continuance is justifiable.

VII. If for any reason the scholarship awarded to a student is terminated, the same may be transferred to another student in accordance with III and IV *supra* and in the order therein indicated.

VIII. Subject to the aforesaid conditions, the award of the scholarship, its continuance and its transfer from one student to another, will be at the discretion of the University Council, after obtaining the recommendations for the School Council.

APPENDIX J.

Revised Courses of Study and Scheme of Examination for the several L.M.P. Examinations recommended by the Board of Studies in Medicine and the Faculty of Medicine.

90 (B)—1. Rules for admission of students.

(a) Candidates who have passed the Mysore Secondary School Leaving Certificate Examination and been declared eligible for college courses of study or any other examination accepted by the University Council as sufficient for this purpose will be eligible for admission.

(b) Candidates for admission should be not less than 16 years of age on the 1st July of the year of admission.

2. COURSES OF STUDY.

The course shall extend over four years.

Candidates for the "L.M.P." Diploma shall be required to attend the following courses of study:—

First Year.

Physics.—One course of lectures with practical demonstrations during the long and short sessions.

Chemistry.—One course of lectures with practical demonstrations during the long and short sessions.

Elements of Biology.—One course of lectures with practical demonstrations during the long and short sessions.

Anatomy.—One course of lectures and dissections during the long and short sessions.

Physiology.—One course of lectures during the long and short sessions.

Second Year.

Anatomy.—One course of lectures during the long and short sessions with dissections extending over the same period.

Physiology.—One course of lectures with demonstrations in Chemical Physiology and Histology during both sessions.

Third Year.

Medicine.—One course of lectures during both sessions.

Surgery.—One course of lectures during long sessions.

General Pathology and Bacteriology.—One course of lectures with practical work during both sessions.

Hygiene.—One course of lectures during both sessions.

Materia Medica.—One course of lectures during the long and short sessions and practical Pharmacy during the short session.

Mental Diseases.—One course of lectures during the short session.

Hospital Work.—(a) Clinical clerking in Medical-wards of a recognised Hospital for 4 months including Post-mortem clerking during the same period.

- (b) Clinical clerking in Surgical-wards for 4 months.
- (c) Out-patient hospital practice for 2 months.
- (d) Clinical demonstrations at the Lunatic Asylum during the short session.
- (e) A course of 5 clinical demonstrations at the Epidemic Diseases Hospital.

Final Year.

Medicine including Tropical Medicine.—One course of lectures during both the sessions.

Surgery.—One course of lectures during the long session.

Operative Surgery, Throat, Nose and Ear Diseases—One course of lectures during the short session.

Midwifery.—One course of lectures during the long session.

Diseases of Women and Children.—One course of lectures during the short session.

Ophthalmology.—A course of lectures extending over 4 months during long session.

Forensic Medicine.—One course of lectures during both the sessions and practical demonstrations in Toxicology during the short session.

Hospital Work.—(a) Clinical clerking in the Medical-wards of a recognised Hospital for 2 months.

- (b) Clinical clerking in the Surgical-wards for 2 months.
- (c) Out-patient hospital practice for 1 month.
- (d) Clinical clerking in the Ophthalmic Hospital for 3 months.
- (e) Clinical clerking at the Maternity Hospital for 3 months.
- (f) A course of 5 demonstrations in Vaccination.

3. EXAMINATIONS.

Candidates shall be required to pass four examinations. The First, Second, Third and Fourth Examinations shall be held twice a year in April and October.

FIRST EXAMINATION.

(a) Candidates shall be required to produce certificates of having undergone an approved course instruction for one year in Physics, Chemistry, Elements of Biology, Anatomy and Physiology.

(b) Candidates shall be examined in the following subjects:—

- (1) Physics.
- (2) Chemistry.
- (3) Elements of Biology.

SECOND EXAMINATION.

(a) Candidates shall be required to produce certificates of:—

- (1) Having passed the First L.M.P. Examination and subsequently having been engaged in medical studies extending over one academic year.
- (2) Having undergone a further course of lectures in Human Anatomy.
- (3) Having undergone a course of dissections extending over not less than 12 months and having dissected the whole body at least once to the satisfaction of his teacher.
- (4) Having undergone a further course of lectures in Physiology.

(b) Candidates shall be examined in the following subjects:—

- (1) Anatomy.
- (2) Physiology.

THIRD EXAMINATION.

(a) Candidates shall be required to produce certificates of:—

- (1) Having passed the Second L.M.P. Examination and having been subsequently engaged in Medical Studies extending over one academic year.
- (2) Having undergone a course of lectures and demonstrations in Pathology and Bacteriology.
- (3) Having undergone a course of lectures and demonstrations in Hygiene.
- (4) Having undergone a course of lectures in Materia Medica and Pharmacology.
- (5) Having undergone a course of practical Pharmacy extending over a period of 3 months.
- (6) Having attended a course of lectures in Medicine.
- (7) Having attended a course of lectures in Surgery.
- (8) Having attended a course of lectures in Mental Diseases.
- (9) Having worked as clinical clerk in the Medical-wards of a recognised hospital for 4 months.
- (10) Having worked as clinical clerk in the Surgical-wards of a recognised hospital for 4 months.
- (11) Having attended the Out-patient hospital practice of a recognised hospital for 2 months.
- (12) Having attended a course of clinical demonstrations at the Lunatic Asylum.
- (13) Having worked as clinical clerk in the Post-mortem room.

(b) Candidates shall be examined in the following subjects:—

- (1) Pathology and Bacteriology.
- (2) Hygiene.
- (3) Materia Medica.

FOURTH OR FINAL EXAMINATION.

(a) Candidates shall be required to produce certificates of:—

- (1) Having passed the Third L.M.P. Examination and having been engaged subsequently in Medical Studies extending over one academic year.

- (2) Having attended a further course of lectures in Medicine including Tropical Medicine.
- (3) Having attended a further course of lectures in Surgery.
- (4) Having attended a course of lectures in Operative Surgery, Throat, Nose and Ear Diseases.
- (5) Having attended a course of lectures in Midwifery and Diseases of Women and Children.
- (6) Having attended a course of lectures in Ophthalmology.
- (7) Having undergone a course of lectures and demonstrations in Forensic Medicine.
- (8) Having worked as a clinical clerk in the Medical-wards of a recognised hospital for 2 months.
- (9) Having worked as a clinical clerk in the Surgical-wards of a recognised hospital for 2 months.
- (10) Having attended the Out-patient department for 1 month.
- (41) Having worked as clinical clerk at the Ophthalmic Hospital for 3 months.
- (12) Having worked as a clinical clerk in the Maternity Hospital for 3 months and having conducted not less than 6 labour cases and witnessed not less than 10 labour cases.
- (13) Having attended a course of demonstrations in vaccination.
- (14) Having attended a course of clinical demonstrations at the Epidemic Diseases Hospital.
- (b) Candidates shall be examined in the following subjects:—
 - (1) Surgery.
 - (2) Medicine.
 - (3) Midwifery.
 - (4) Forensic Medicine.

N.B.—1. No candidate shall be declared to have passed in any of the above examinations unless he obtains not less than 40 per cent of marks in each subject.

2. Those who obtain 70 per cent of marks or more in the aggregate shall be placed in "First Class."
3. Candidates who fail in the Final Examination but obtain 60 per cent or more in any subject will be exempted from appearing in that subject at a subsequent examination.
4. Candidates who fail in the Final Examination shall be required to produce evidence of further study in the subjects in which they appear at a subsequent examination.

4. FEES.

(a) Every student shall pay a registration fee of Rs. 5 on admission and a tuition fee of Rs. 60 per annum in two equal instalments in the months of July and January every year. Students who fail in the Final Examination shall be required to pay a tuition fee of Rs. 30 for a course extending over 6 months or less.

(b) Each candidate shall pay a fee of Rs. 10 for the First, Second and Third Examinations and Rs. 15 for the Final Examination or part thereof.

5. EXAMINATION FOR THE L.M.P. DIPLOMA.

First Examination.

Subject	Time	Max. Marks for written	Max. Marks for Viva Voce
1. Physics	1 paper of 2 hours	100	50
2. Chemistry	1 paper of 3 hours	100	50
3. Elements of Biology	1 paper of 2 hours	100	50

Second Examination.

1. Anatomy	1 paper of 3 hours	100	50
2. Physiology	do	100	50

Third Examination.

1. Pathology and Bacteriology	1 paper of 3 hours	100	50
2. Hygiene	do	100	50
3. Materia Medica	do	100	50

Final Examination.

1. Medicine	1 paper of 3 hours	100	50	Clinl. 50
2. Surgery	do	100	50	50
3. Midwifery	do	100	50	
4. Forensic Medicine	do	100	50	

N.B.—The date and hour of Clinical and Viva Voce Examination will be notified after the written Examination.